Surface and Atmosphere Radiation Budget (SARB)

Clouds and the Earth's Radiant Energy System (CERES)
Science Team Meeting at UK Met Office, Exeter (25-27 Oct 2006)

T. P. Charlock (NASA LaRC)
Fred G. Rose (AS&M) algorithm development *& Thurs AM talk on "Synoptic SARB"*
David A. Rutan (AS&M) CAVE validation
Zhonghai Jin (AS&M) coupled ocean atmosphere radiative transfer
. **Seiji Kato** (H.U.) - modification of LaRC Fu-Liou code
Wenying Su (H.U.) - surface UV and PAR algorithms
Lisa H. Coleman, Thomas E. Caldwell, Scott Zentz (SAIC) - Data Management

D. Fillmore, W. Collins (NCAR) MATCH; **A. Lacis** (GISS) dust optics
Greg Schuster (LaRC), **Ken Rutledge** (AS&M) **-** COVE ocean platform, aerosols

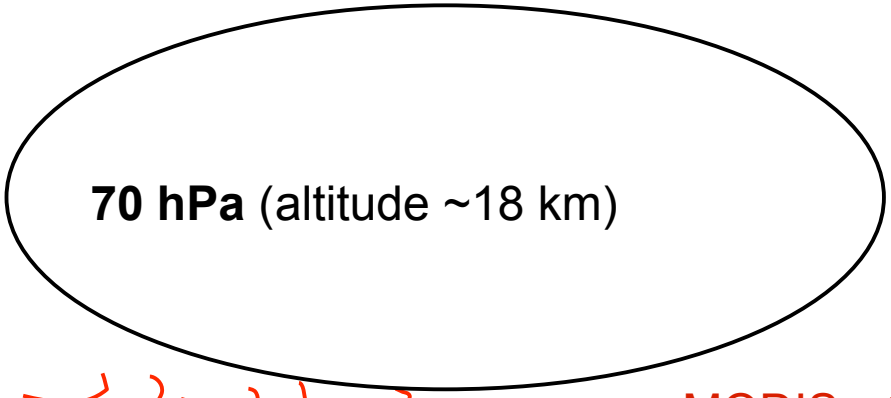
SARB/SOFA Working Group Thurs. AM:
Questions (!#@) and Answers (?)

www-cave.larc.nasa.gov/cave/ or goggle "CERES CAVE"
Easy to use subsets of data, on line radiative transfer, ocean albedo tables…

Ungridded SARB vertical profile at ~2,000,000 CRS footprints/day

Langley Fu-Liou radiative transfer: Kato 2005 SW upgrade, retains Kratz-Rose window

NCEP O3(z)
Mostly from SBUV/2



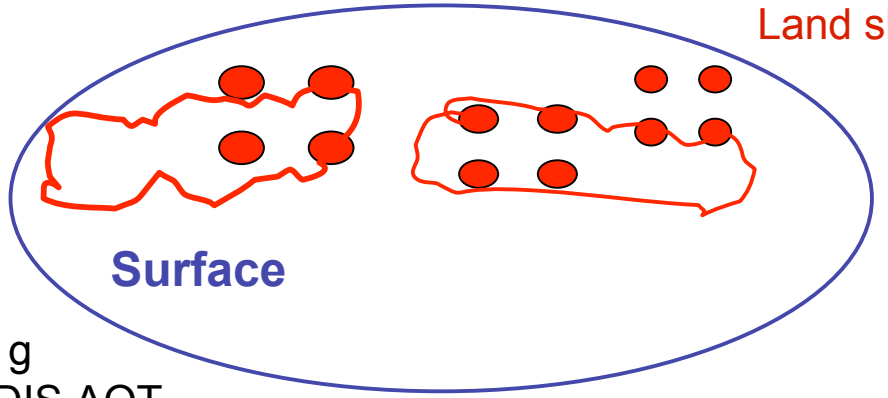
MINNIS modis

GSFC NWP

GEOS4 T(z), q(z), surface wind
Wind speed affects ocean surface albedo

Modis Atmosphere Team

MODIS ~1km pixels provide
Cloud properties (almost always)
Aerosol AOT (sometimes)
Land skin temperature (if clear)



Collins NCAR

MATCH aerosols
Always used for SSA & g
Used for AOT if no MODIS AOT

Wielicki
Loeb
Priestley

~20-50 km

Large CERES footprint for TOA flux

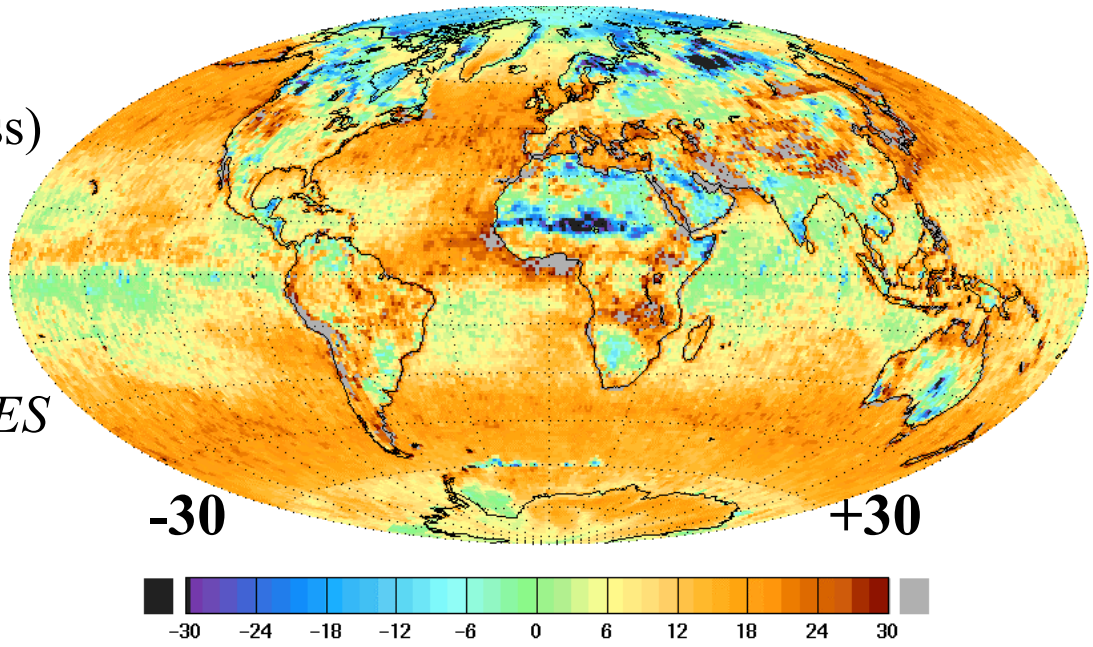
Monthly maps from CAVE home page

Reflected SW at TOA (day overpass)

Observed = 241.5 Wm-2

Bias = 11.0 Wm-2

Calculations reflect more than CERES



Bias = Untuned - Observed

CERES Terra FM1 FSW Ed2C

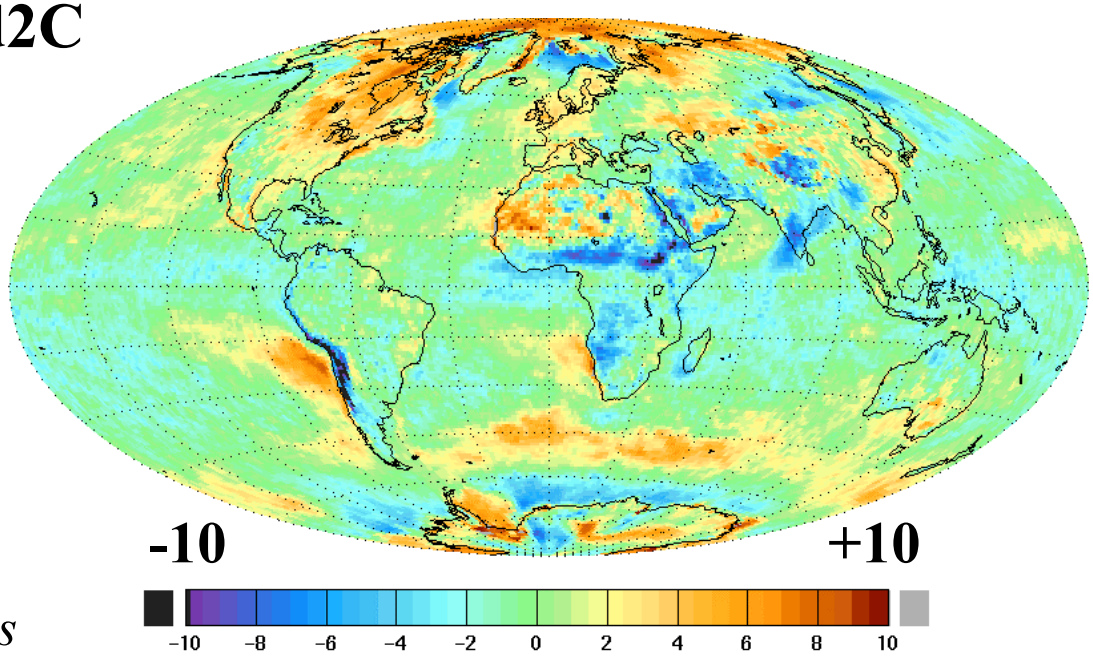
March 2003

OLR (day + nite)

Observed = 237.2 Wm-2

Bias = 0.0 Wm-2

Large regional biases in calculations



www-cave.larc.nasa.gov/cave/ or goggle "CERES CAVE"

NASA Langley CERES ARM Validation Experiment CAVE

Welcome to the CAVE web site. Data collected in this effort are meant for use in validation studies of Clouds & The Earths Radiant Energy System (CERES) instruments operating on the Tropical Rainfall Measurement Mission (TRMM) and Earth Observing Systems(EOS) Terra (soon Aqua) satellites.

Important Change to CAVE Surface flux, Aerosol, Meteorology (SAM) Files

Please Read for Details

CAVE Data Info & Validation Results

Overview and Site Map

Plot CAVE Data On Line

Validation Plots & Statistics

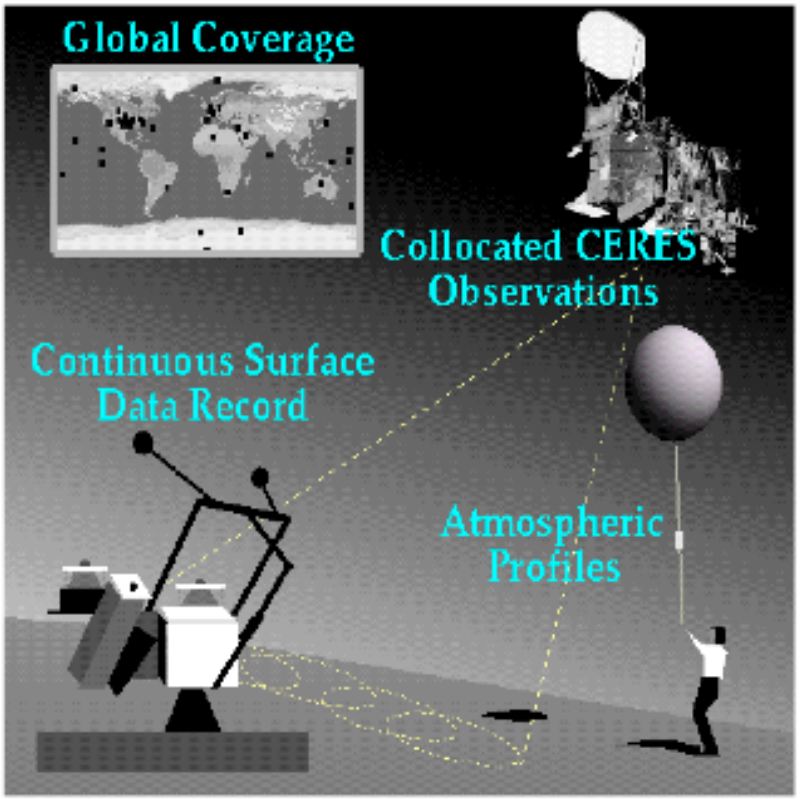
Publications

Cloud Fraction In CAVE

Aerosols In CAVE

Updates Mar 23, 2005

The Group



Referencing CAVE data

Radiation Transfer & Related Links

COART Coupled Ocean-Atmos RT Model

Ocean Albedo Look-up Table

Point & Click Fu & Liou

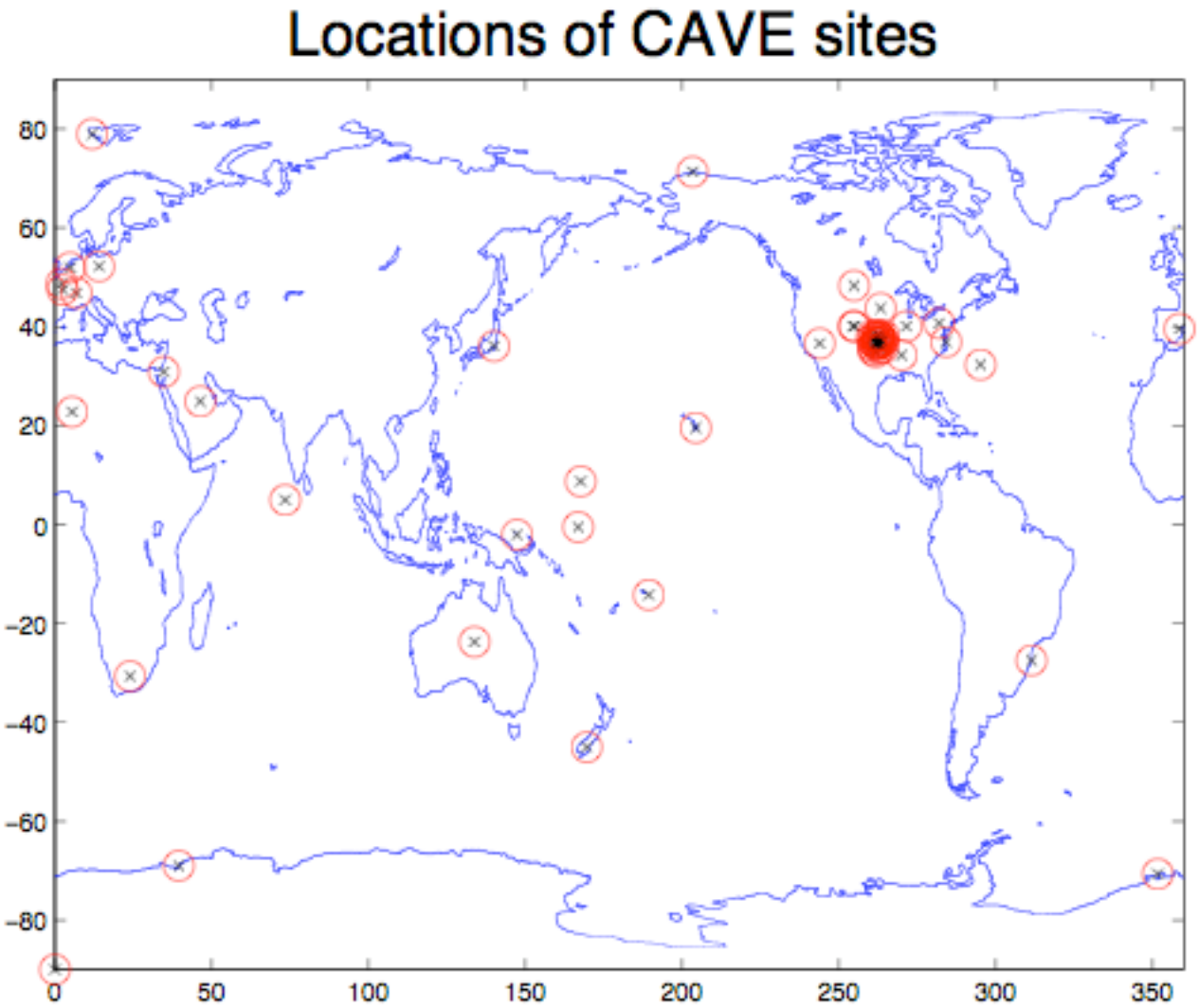
CRS Advice

CLAMS

ULDB Balloon Observations

Site Map

CERES ARM Validation Experiment (CAVE) includes BSRN, SURFRAD



www-cave.larc.nasa.gov/cave/ or goggle "CERES CAVE"

Surface Flux Validation

Instantaneous Footprint Results
Terra, 60 Months of CRS Ed2B, ("clear" – imager)

Downward Untuned Surface Flux Biases (Model-Obs)(W/m2)					SFC Aerosol Forcing		
	All Sky		Clear Sky		Clear-Pristine		SW
	LW	SW	LW	SW	LW	SW	CNA*
ARM/SGP	-7	+8	-8	+3	+1	-16	-16
Island Sites	-3	+25	0	+14	+1	-9	-7
Polar Sites	-4	+11	-7	-3	+0	-4	-3
SURFRAD	-8	+11	-9	-0	+1	-17	-16
European	-6	+21	-3	+0	+2	-27	-19
Validation Sites	-6 (23)	+13 (94)	-9 (15)	+2 (29)	+3	-16	-10

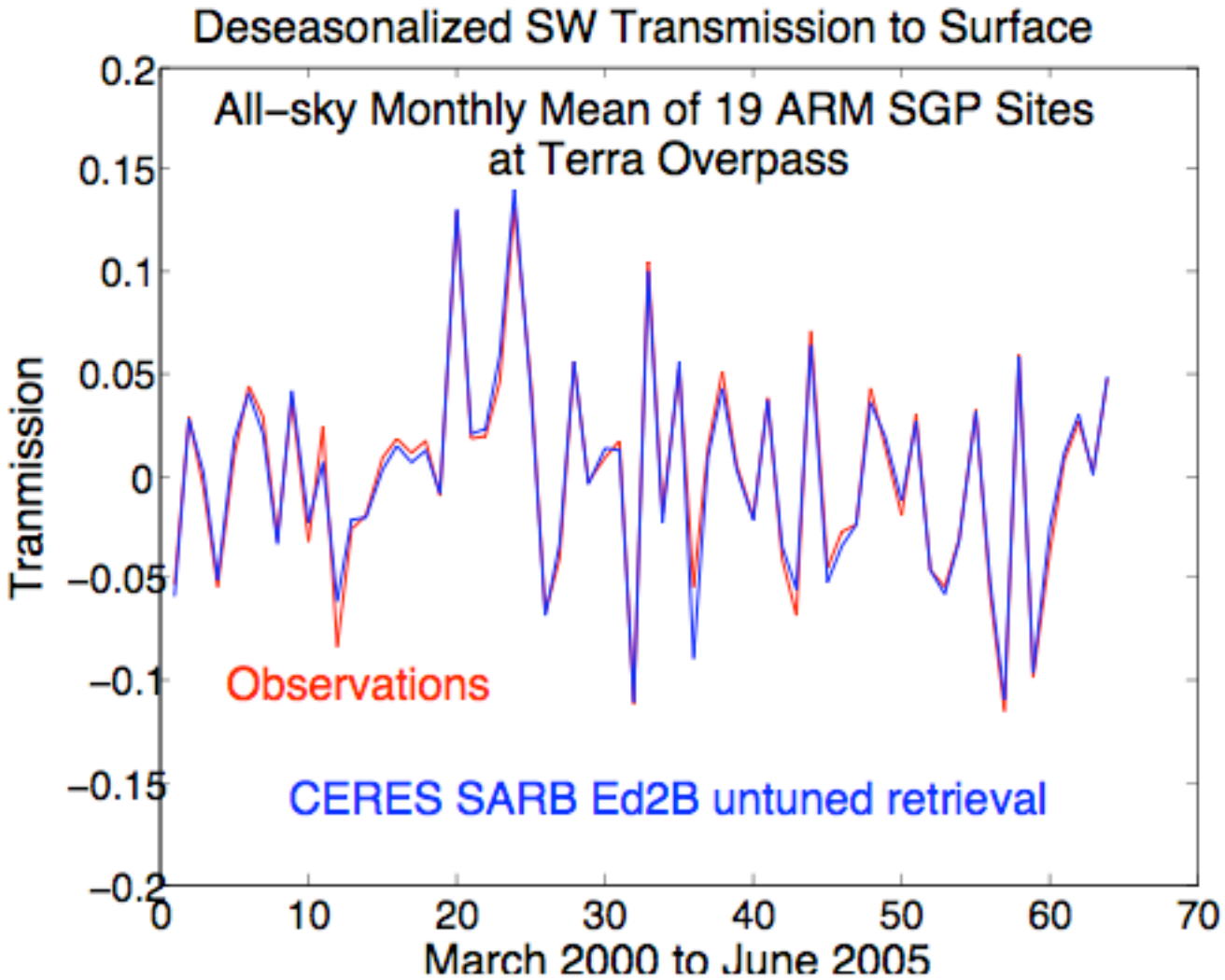
ARM SGP for 64 months **Mean (RMS) of Bias for All-sky SW insolation**

4 (89) for E13 site (Central Facility)

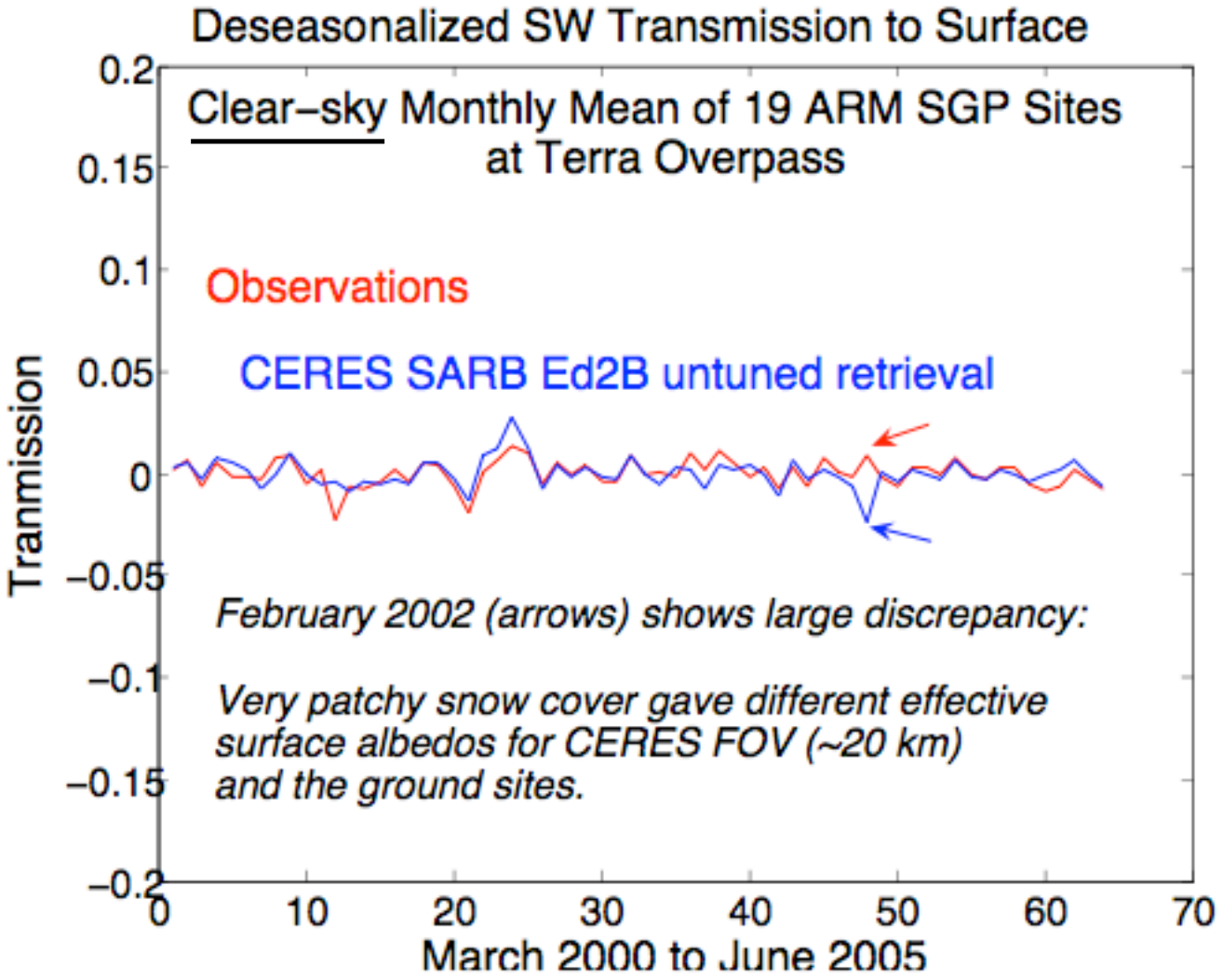
10 (87) for 19 SGP sites

10 (30) for 19 sites as a virtual daily "grand" site

10 (13) for 19 sites as a virtual monthly "grand" site



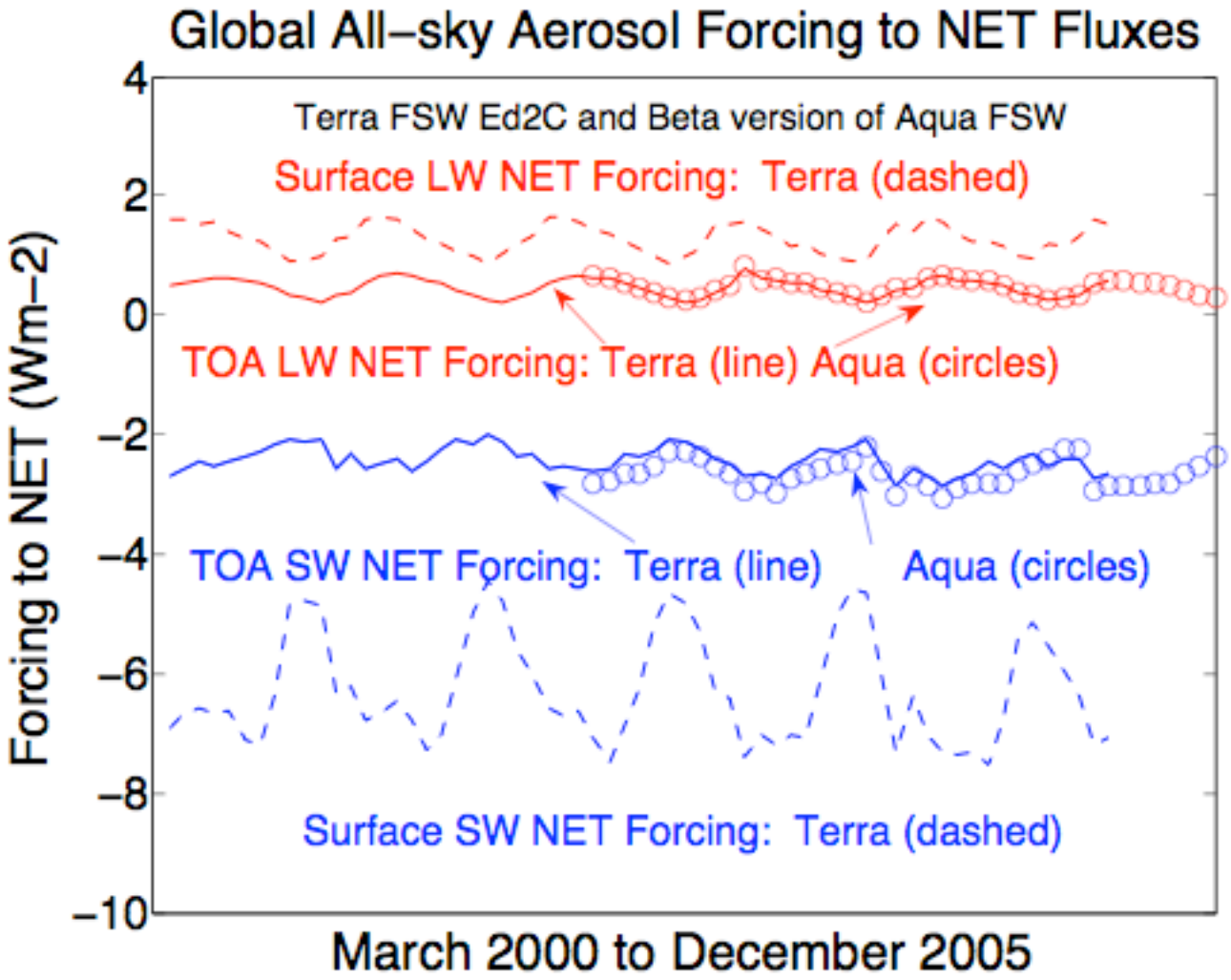
Using all 19 SGP sites as a virtual monthly "grand" site, CERES SARB retrieval captures the interannual variability of all sky insolation.

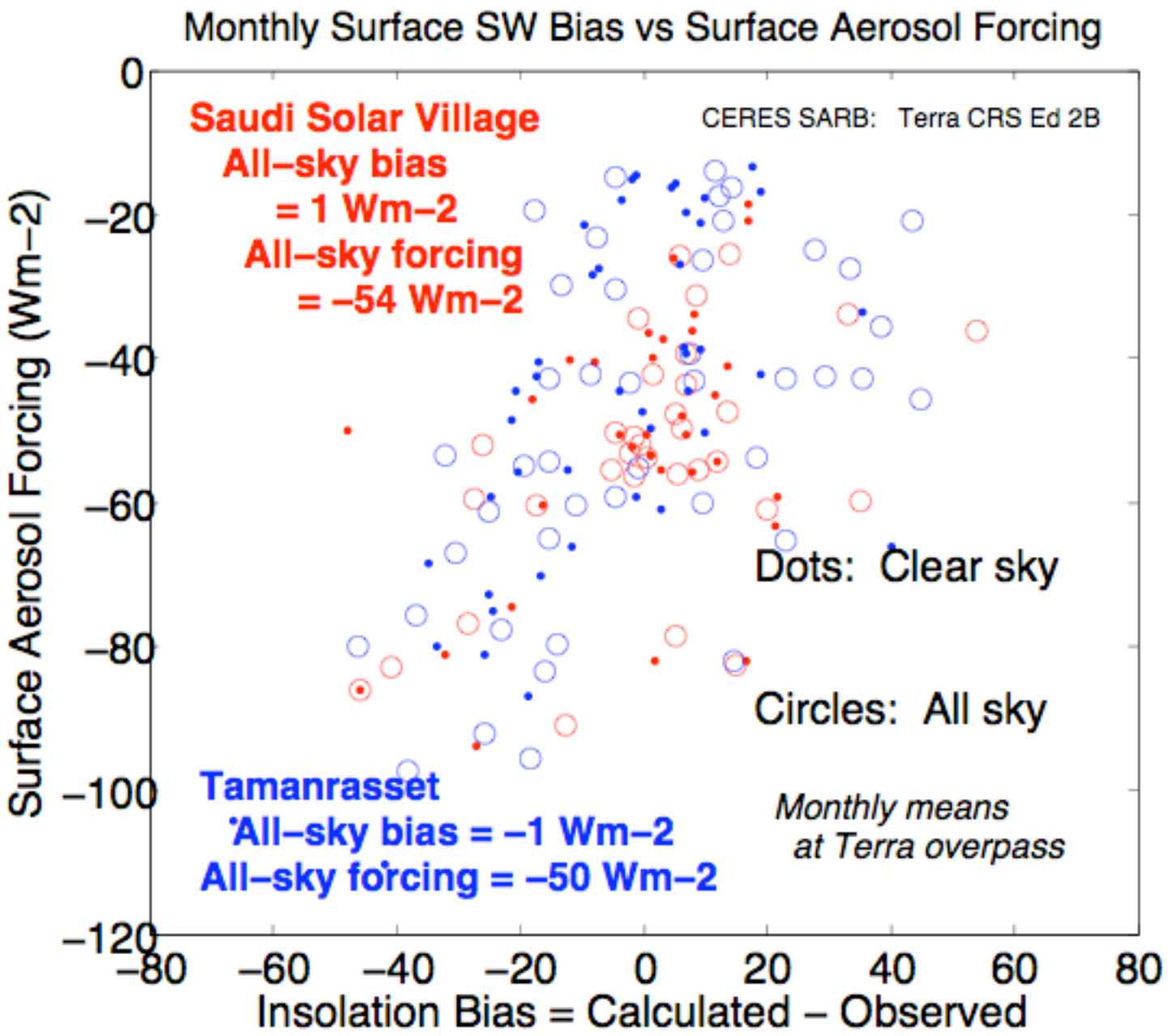


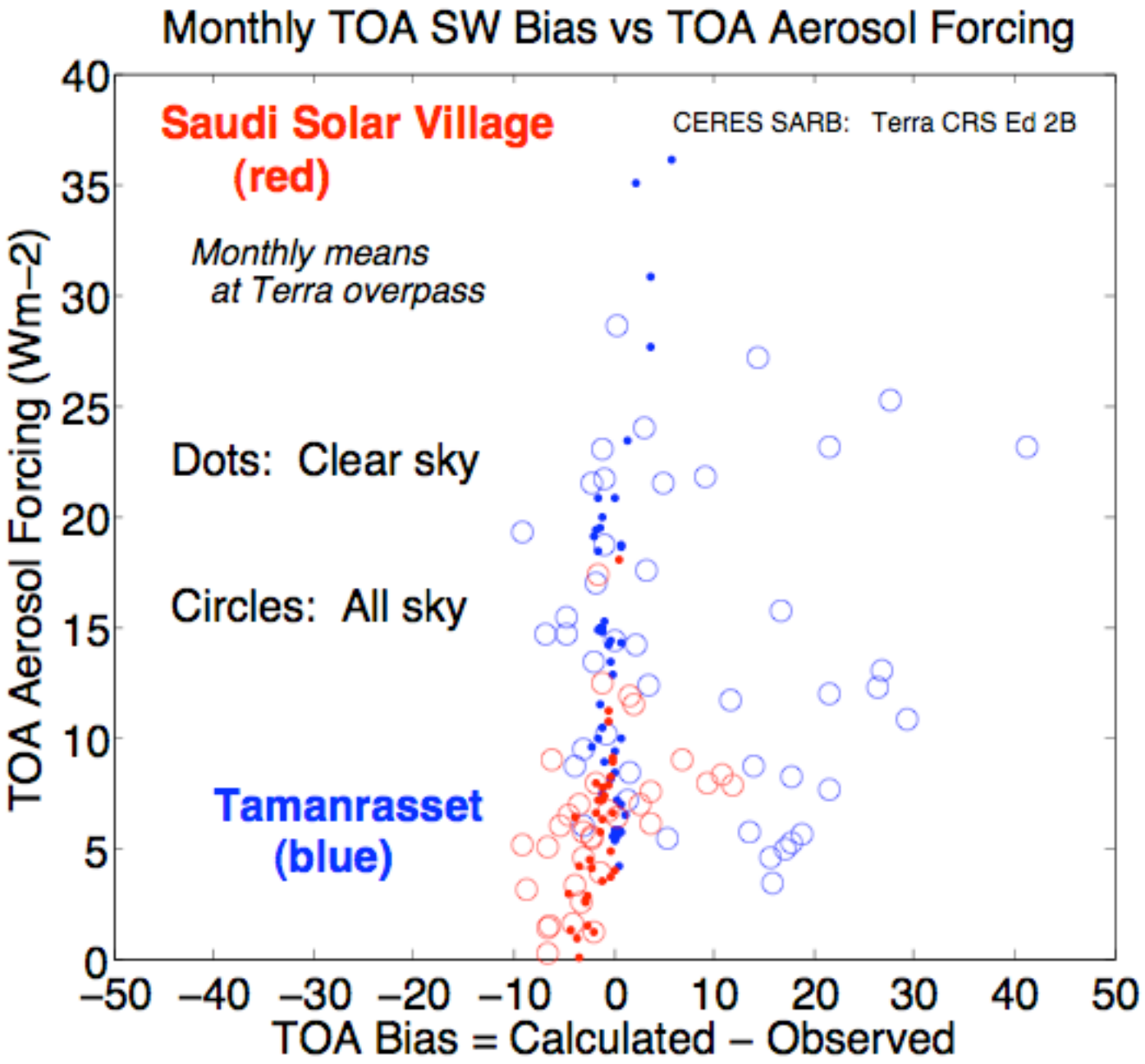
Retrieval does not capture interannual variability in clear-sky transmission well.

But ensemble mean aerosol forcing (-17 Wm^{-2} from entire raw time series) is okay,

as insolation bias of raw time series is only 3 Wm^{-2} for clear skies.


Global All–sky Aerosol Forcing to NET Fluxes
Terra FSW Ed2C and Beta version of Aqua FSW
Surface LW NET Forcing: Terra (dashed)
TOA LW NET Forcing: Terra (line) Aqua (circles)
TOA SW NET Forcing: Terra (line)
Aqua (circles)
Surface SW NET Forcing: Terra (dashed)
Forcing to NET (Wm–2)
4
2
0
–2
–4
–6
–8
–10
March 2000 to December 2005


Monthly Surface SW Bias vs Surface Aerosol Forcing
Saudi Solar Village
All–sky bias
= 1 Wm–2
All–sky forcing
= –54 Wm–2
CERES SARB: Terra CRS Ed 2B
Dots: Clear sky
Circles: All sky
Monthly means
at Terra overpass
Tamanrasset
All–sky bias = –1 Wm–2
All–sky forcing = –50 Wm–2
Surface Aerosol Forcing (Wm–2)
0
–20
–40
–60
–80
–100
–120
–80
–60
–40
–20
0
20
40
60
80
Insolation Bias = Calculated – Observed



Greg Schuster will show theory of cloud-aerosol retrieval problem later…

Surface Flux Validation

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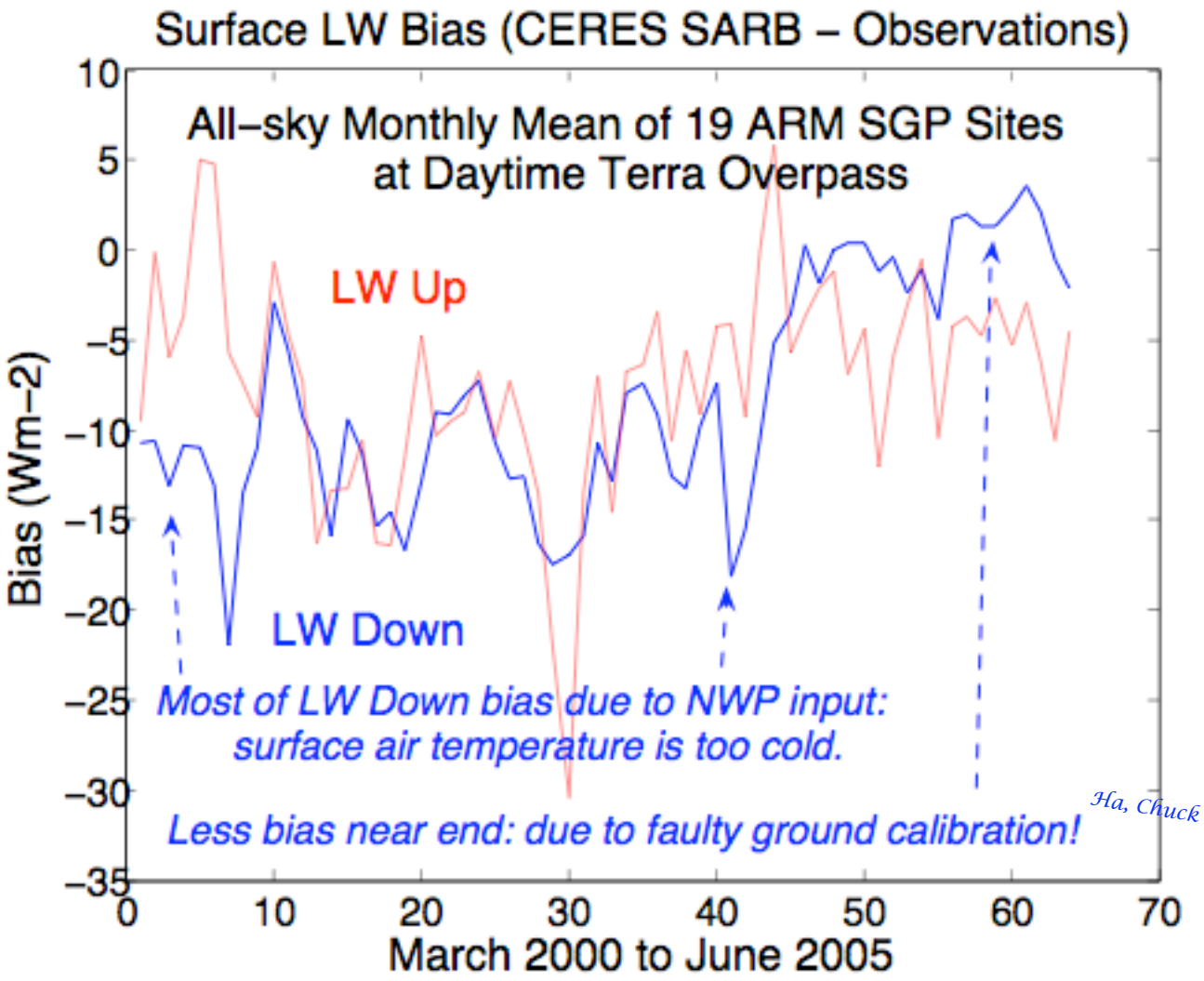
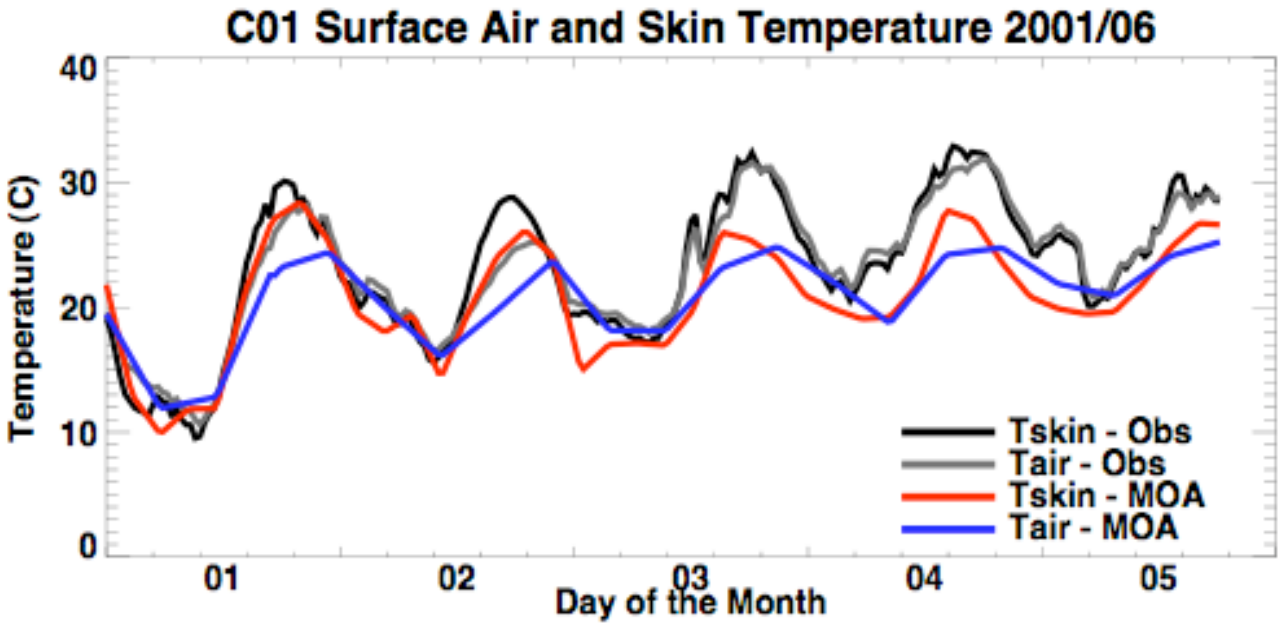
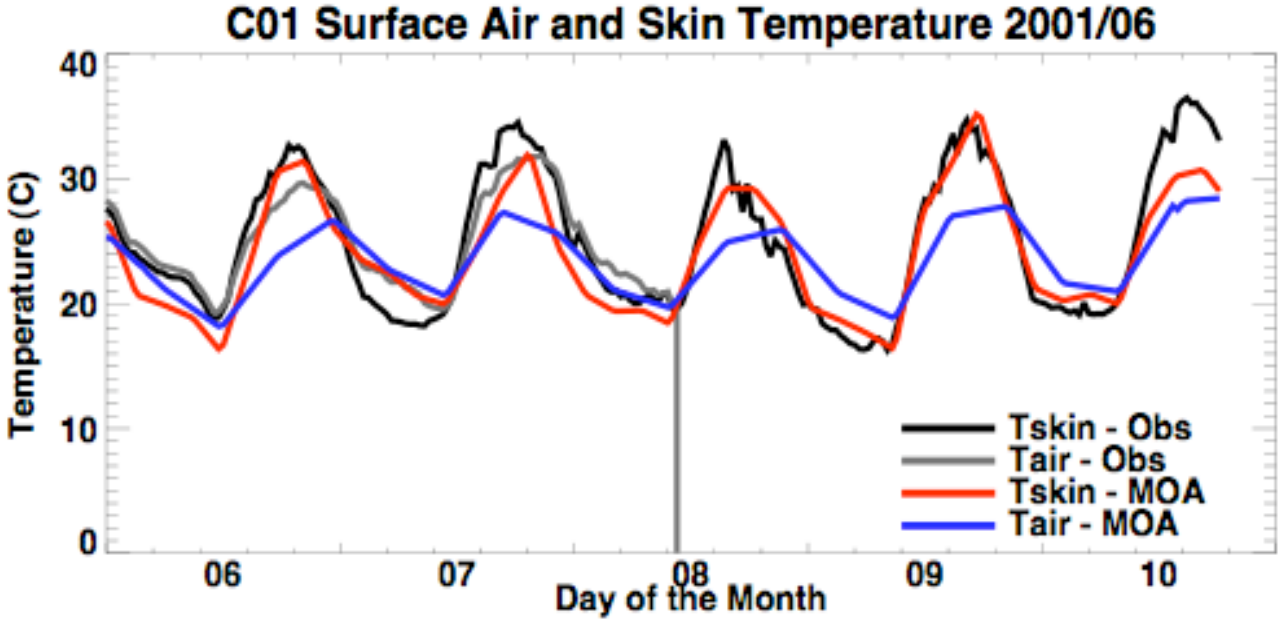

Surface LW Bias (CERES SARB – Observations)
All–sky Monthly Mean of 19 ARM SGP Sites
at Daytime Terra Overpass
LW Up
LW Down
Most of LW Down bias due to NWP input:
surface air temperature is too cold.
Less bias near end: due to faulty ground calibration!
Ha, Chuck
Bias (Wm–2)
March 2000 to June 2005
10
5
0
–5
–10
–15
–20
–25
–30
–35
0
10
20
30
40
50
60
70





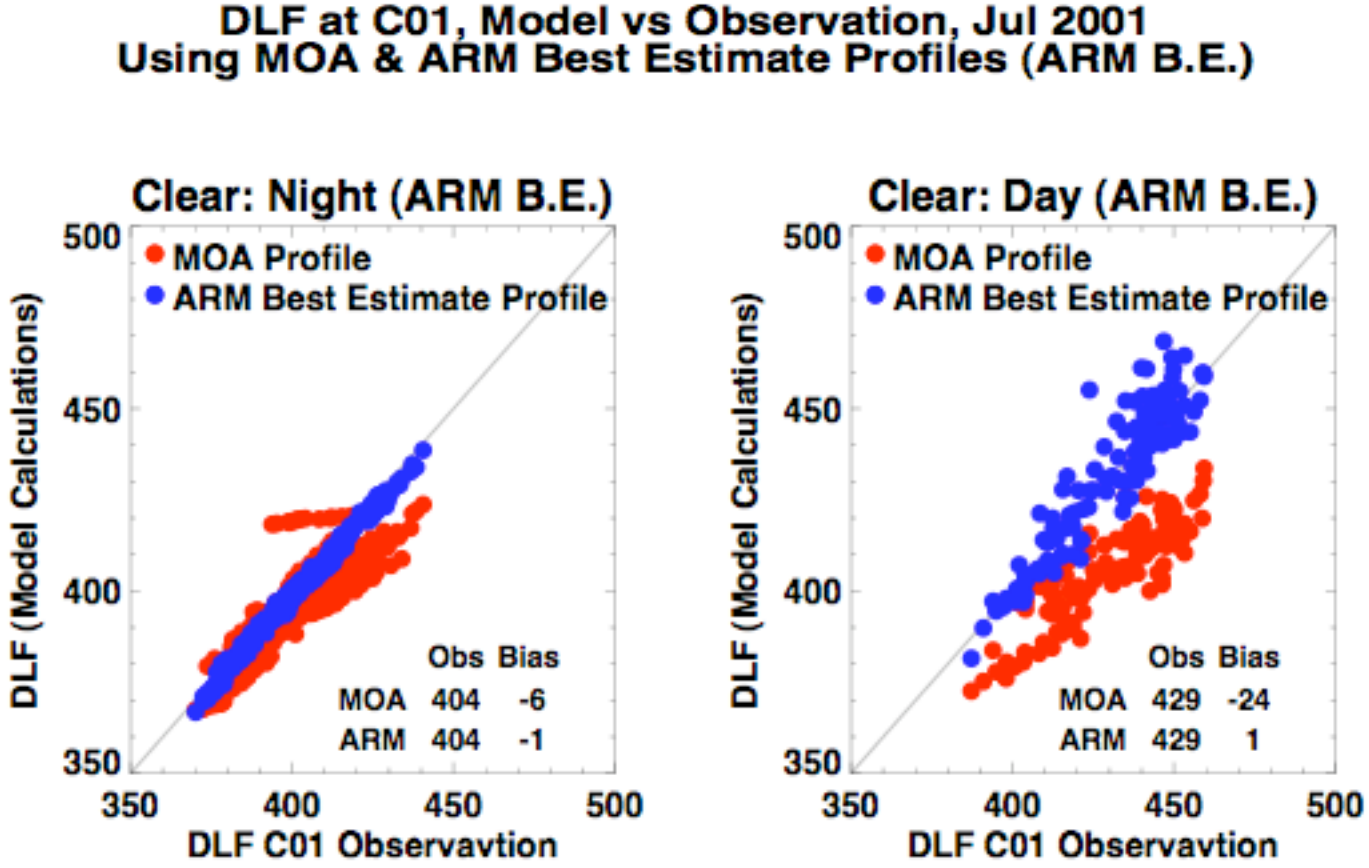
English translation

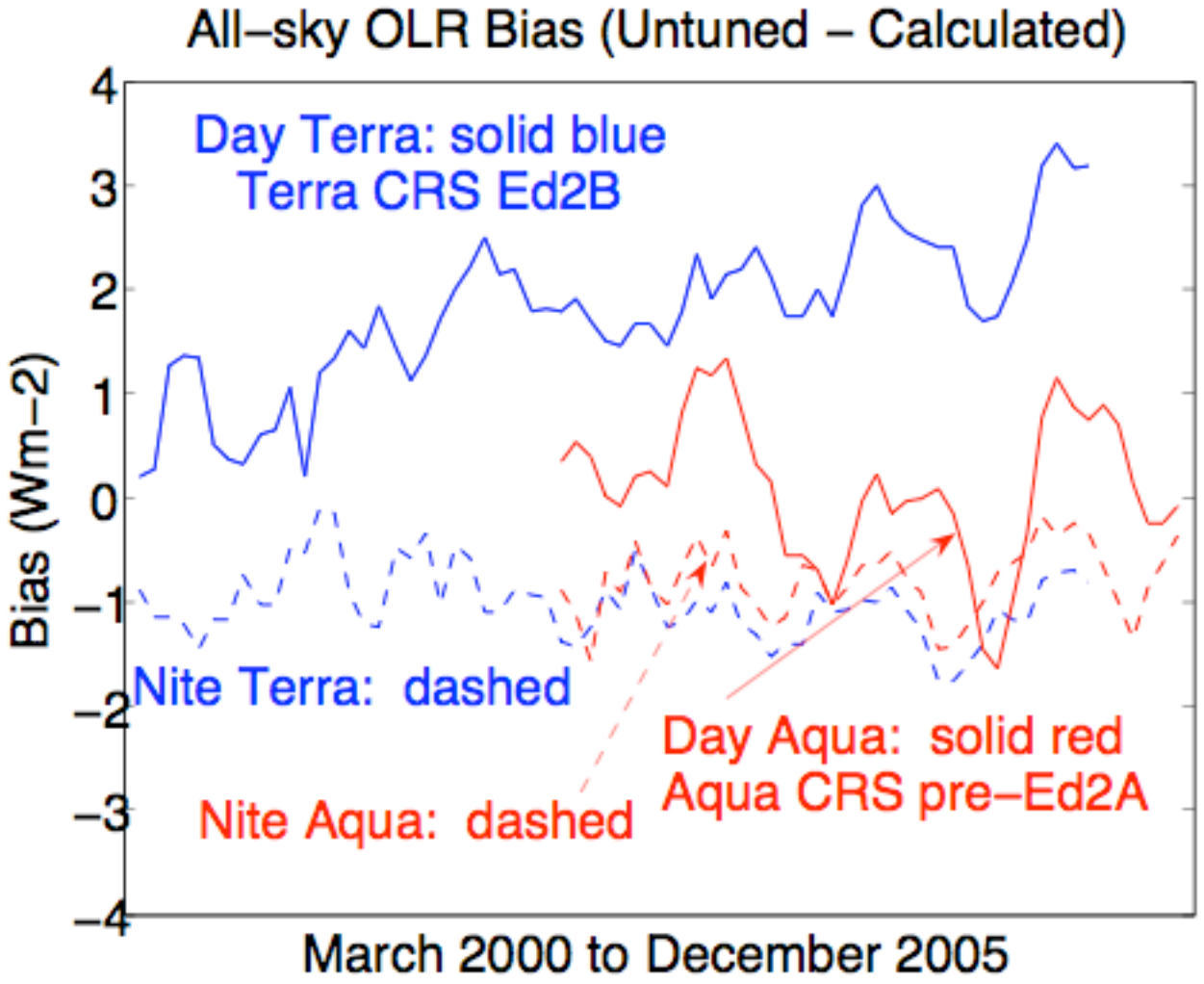
Obs: ground-based observation

MOA: temperature and humidity field (GEOS4) used for calculations

Comparison for a full month: Recalculate clear LW all day using MOA field (GEOS4) and then again with ARM's local "Best Estimate" sounding.

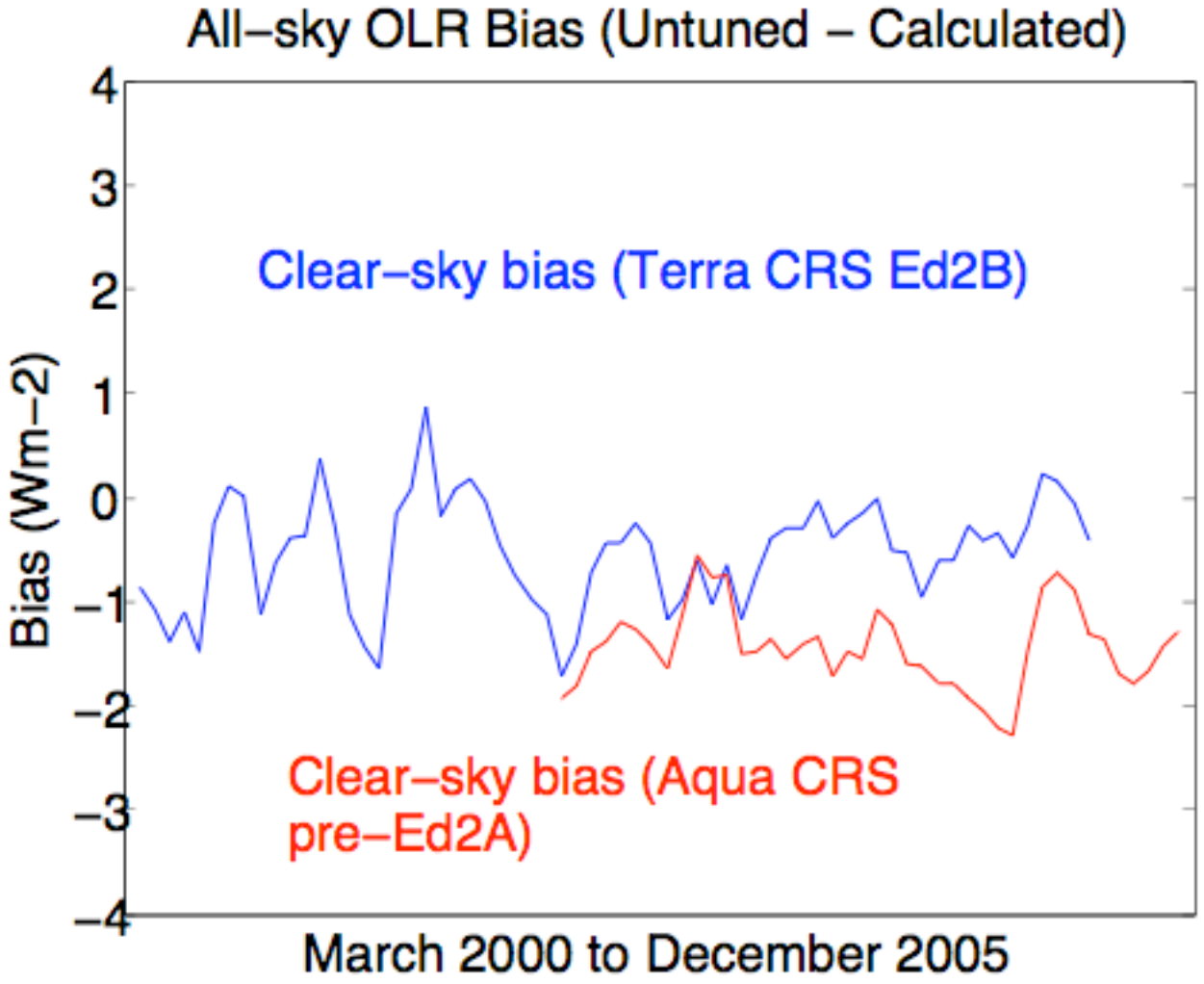
This shows that the MOA input causes the bias in downward LW.



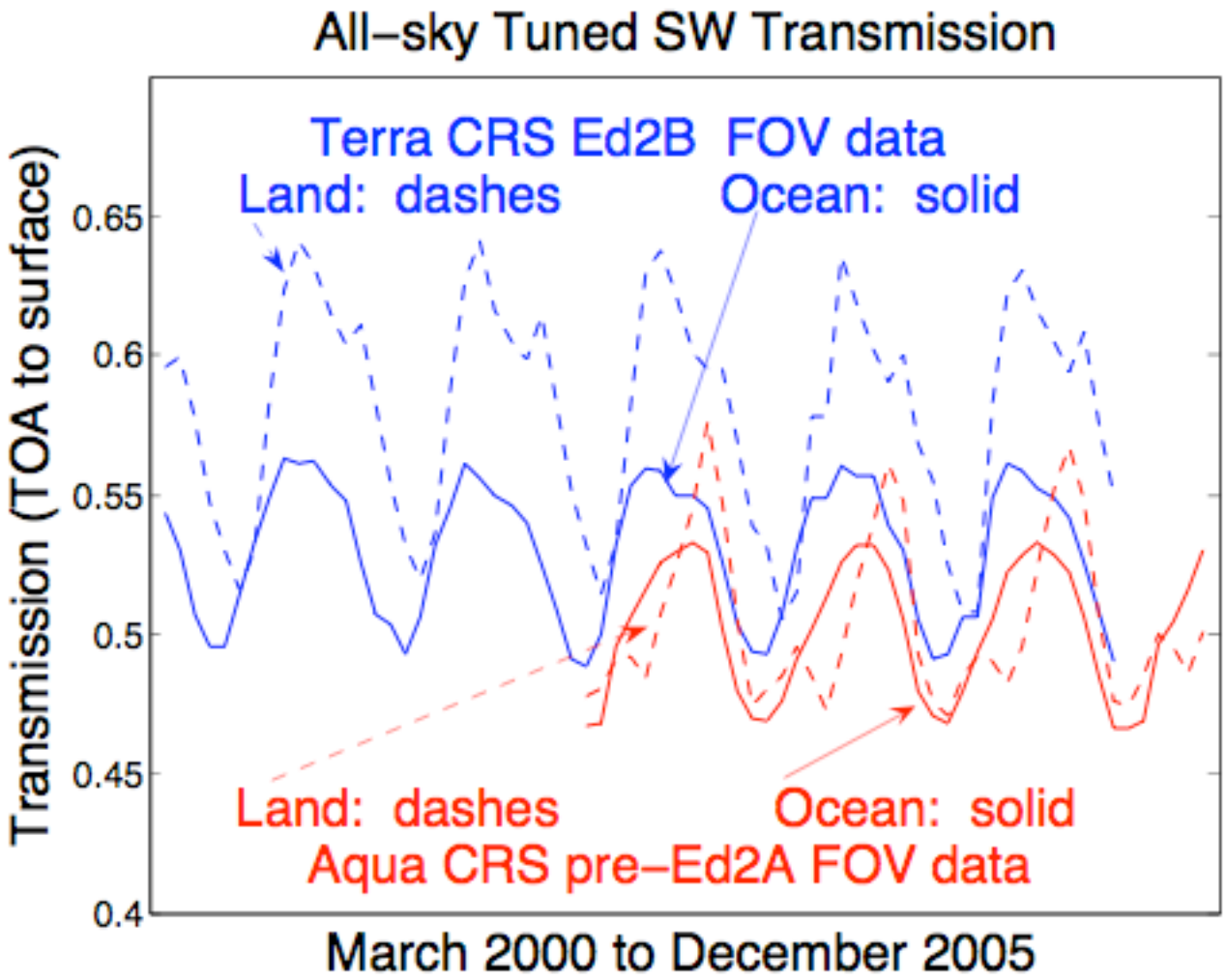


CRS: SARB statistics from the raw field of view (FOV) -- not gridded

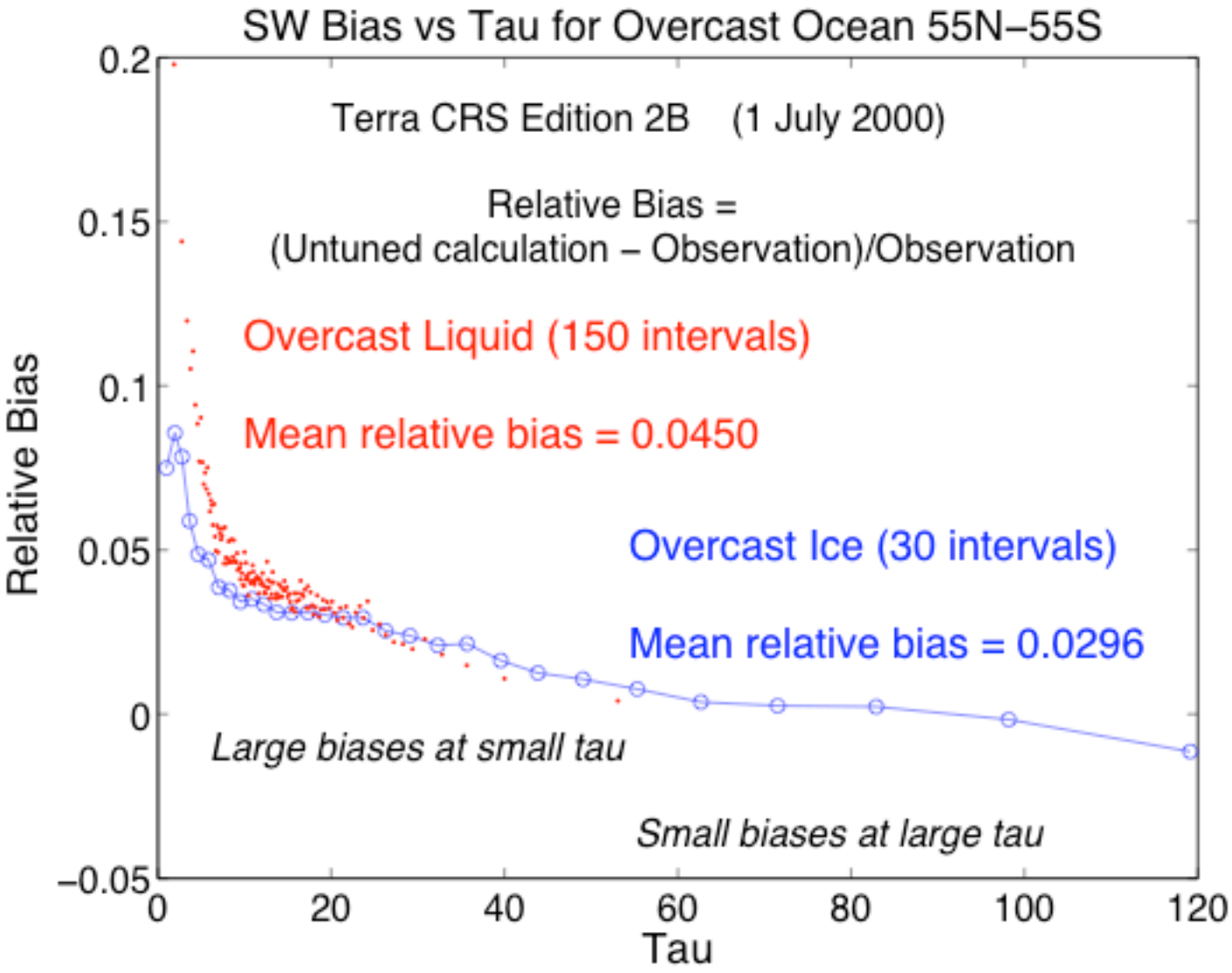
Note the drift in bias for Terra daytime OLR.



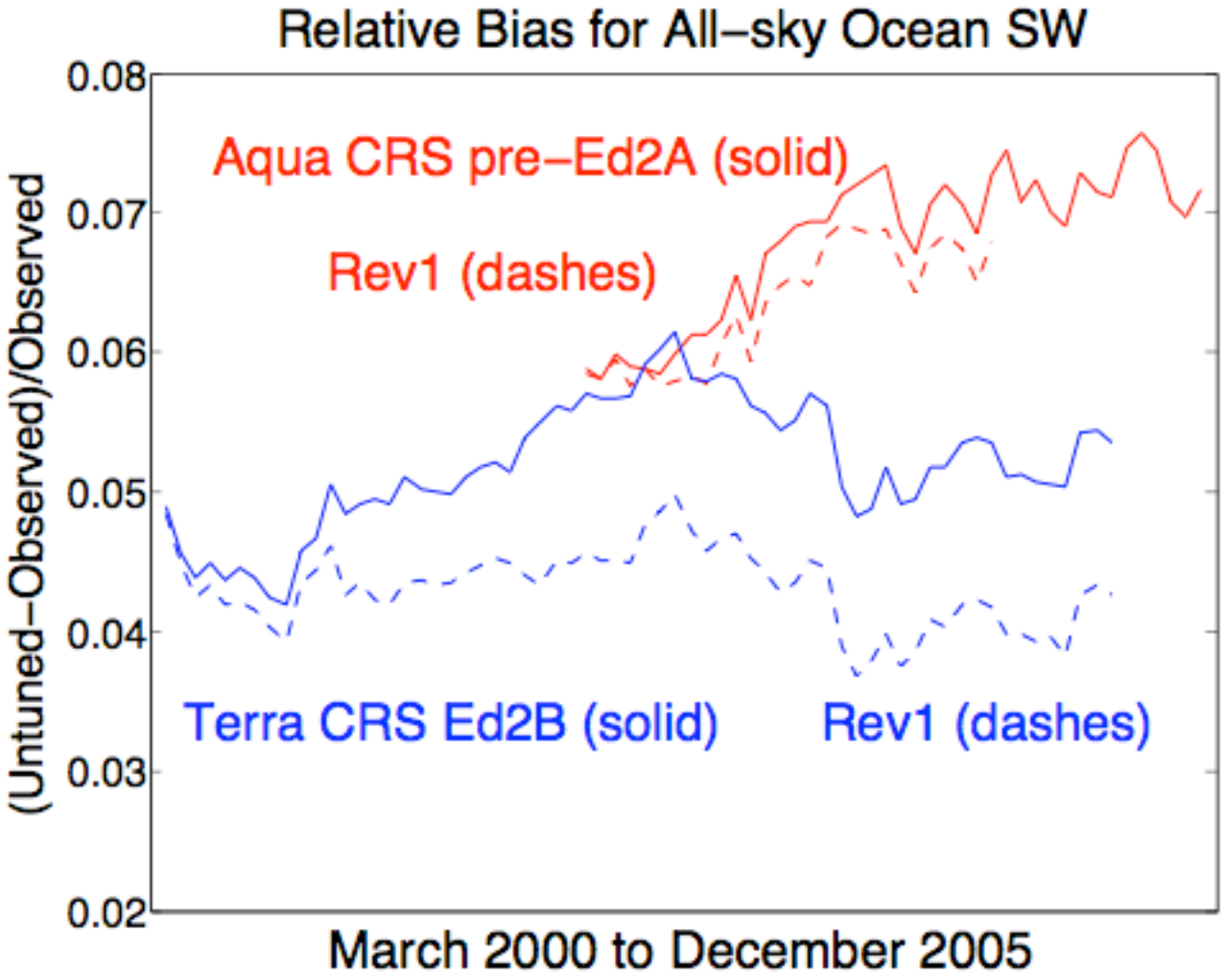
CRS: SARB statistics from the raw field of view (FOV) -- not gridded



CRS: SARB statistics from the raw field of view (FOV) -- not gridded



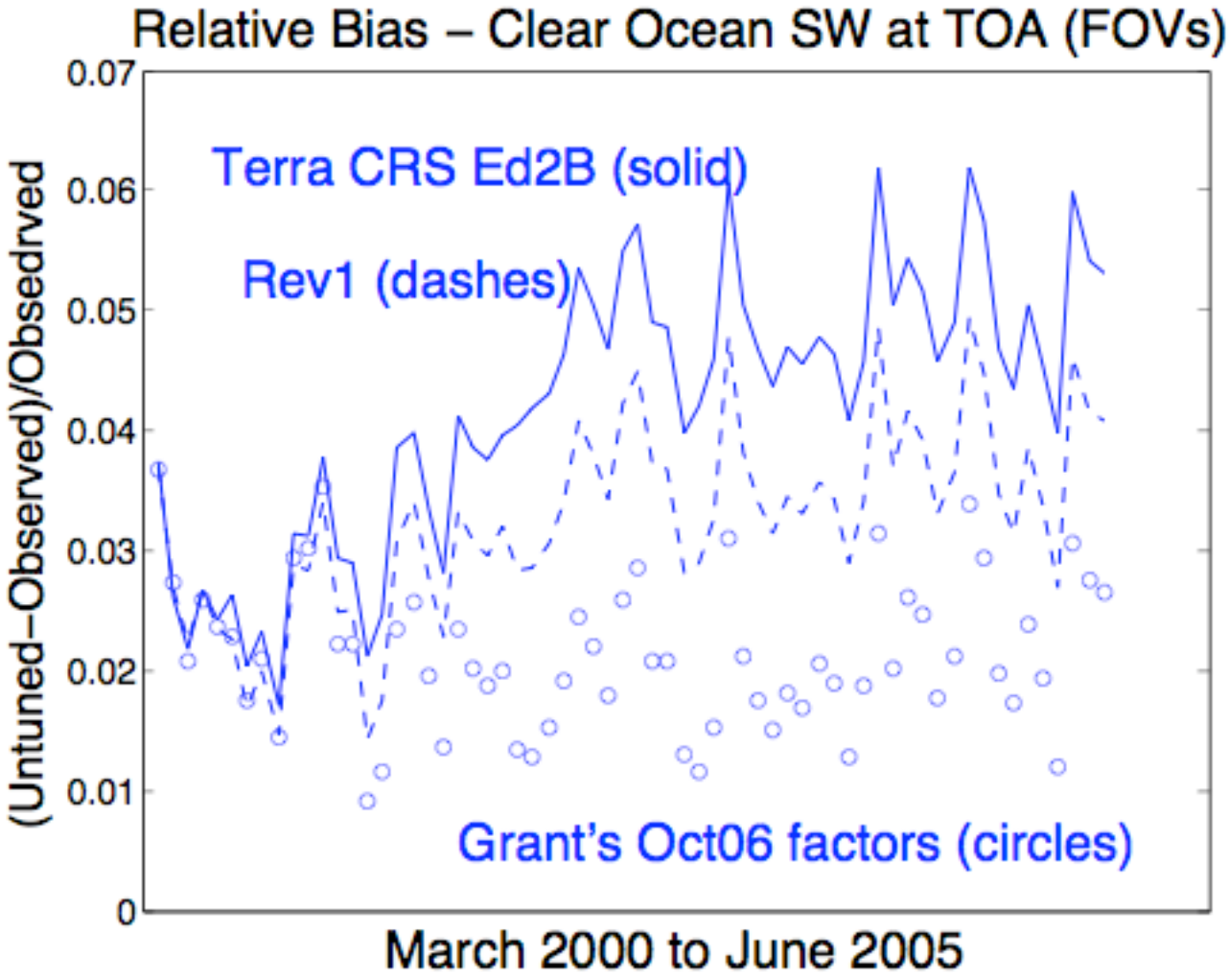
Plot was also from May meeting. Earler this week, DeWitte showed differences for cloudy-sky SW radiances (GERB-CERES) that were quite similar to those above for cloudy-sky SW fluxes (Untuned calculations - CERES).



CRS: SARB statistics from the raw field of view (FOV) -- not gridded

*Later presentation on **COVE ocean platform by Schuster** will show*

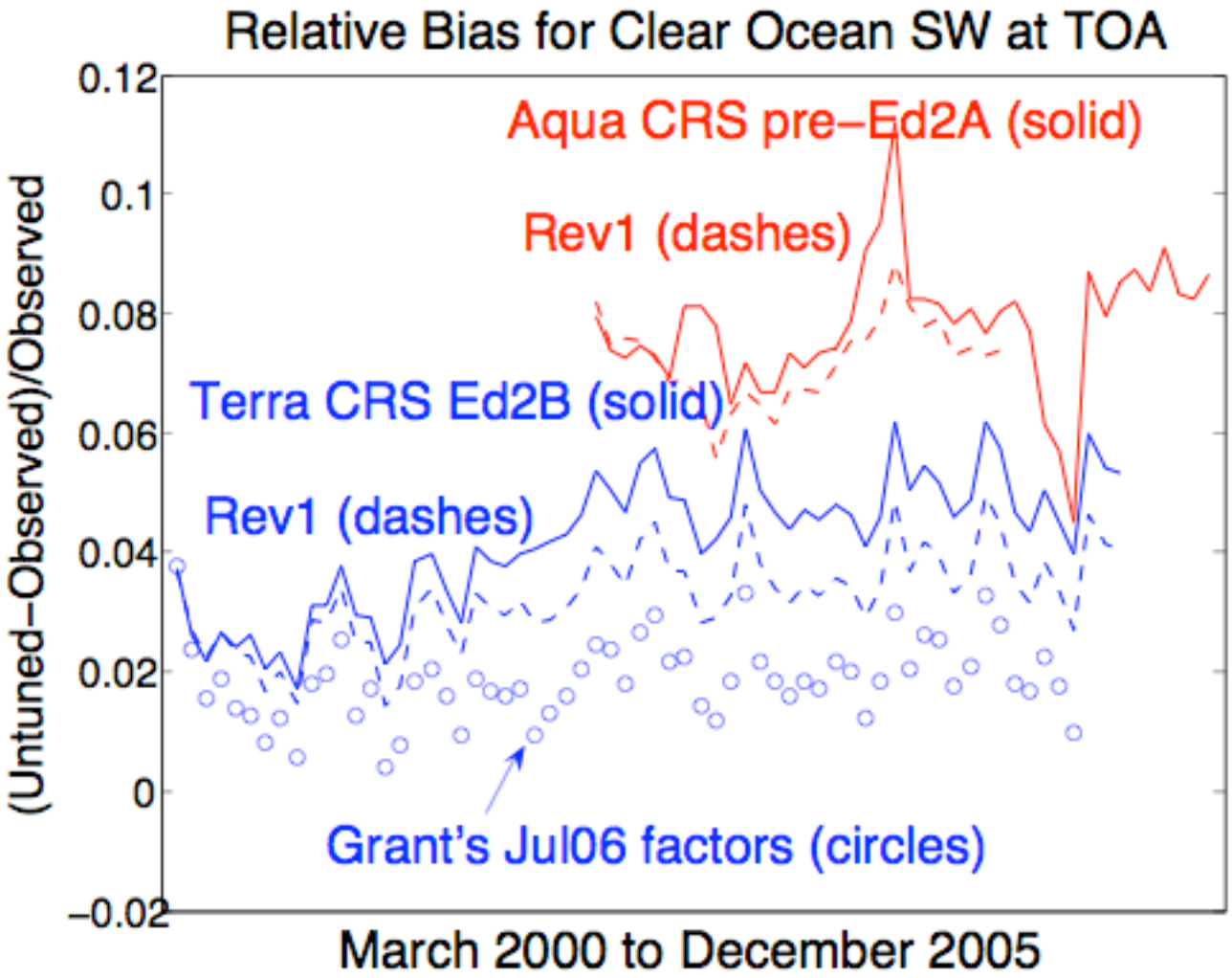
(1) TOA bias at COVE is similar to above *(2) surface bias at COVE is low*

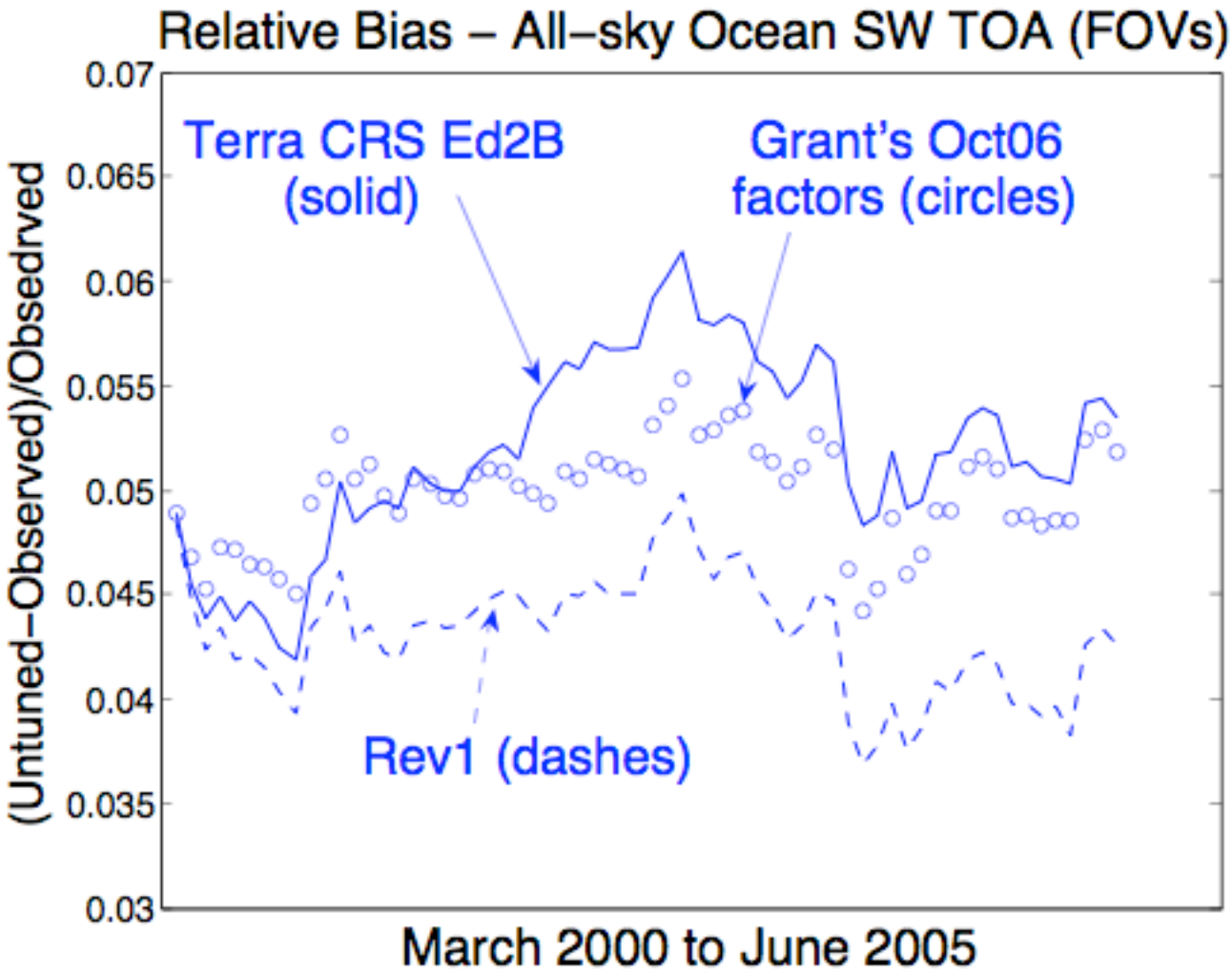


CRS: SARB statistics from the raw field of view (FOV) -- not gridded

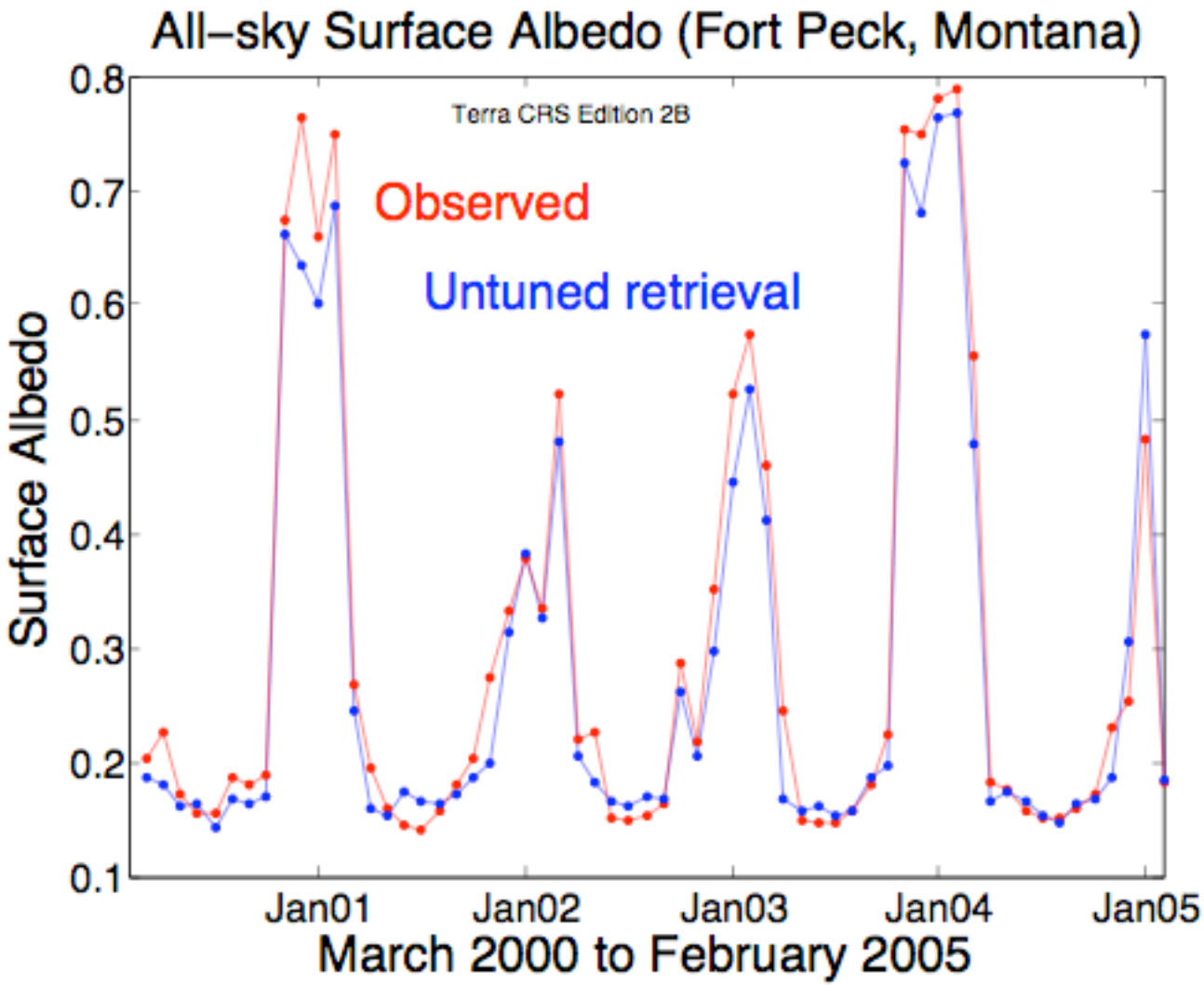
Ocean surface albedos for GCMs: goggle "CERES CAVE" seek CAVE home page

Zhonghai Jin presents on clear-sky ocean SW later…

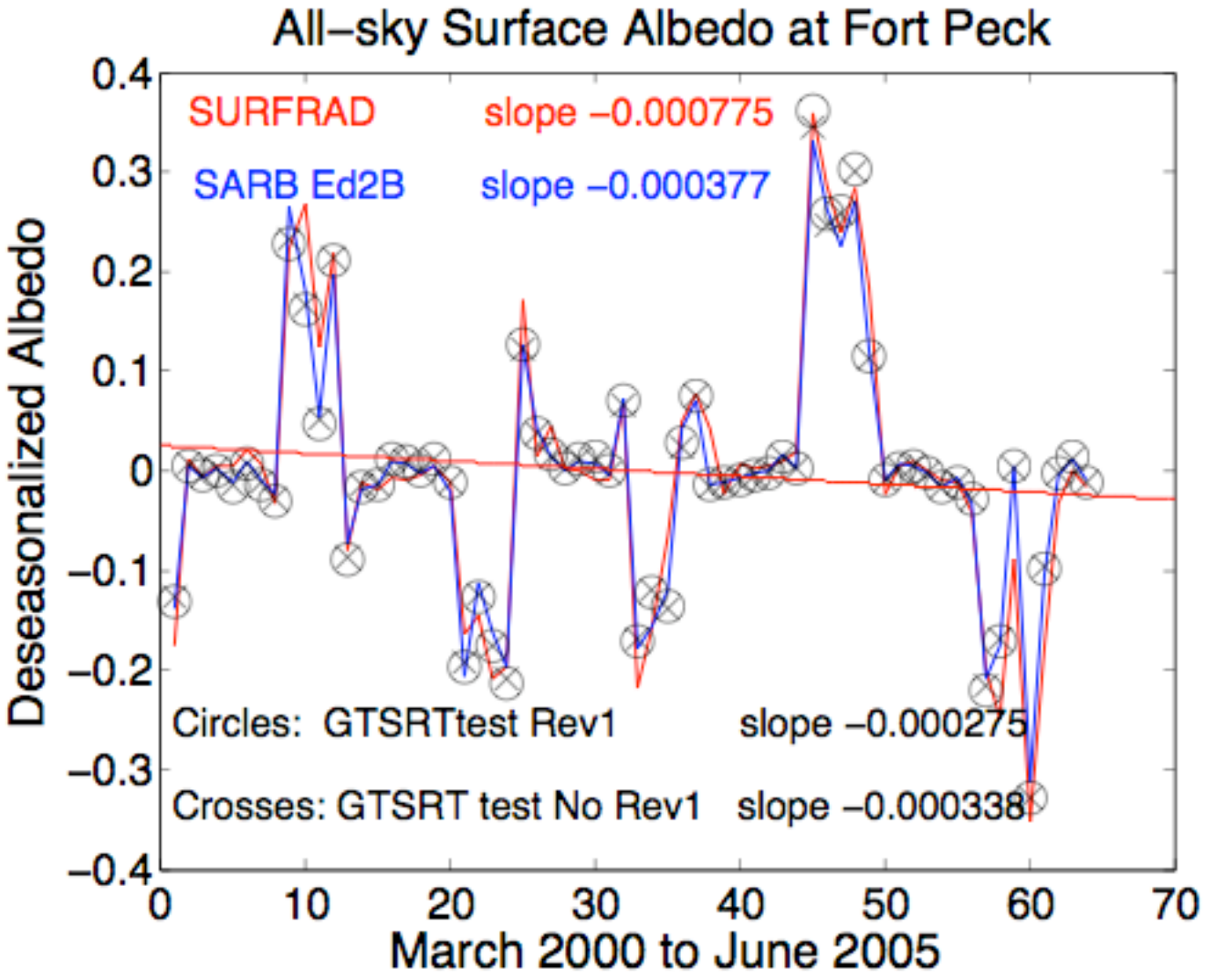

Relative Bias for Clear Ocean SW at TOA
(Untuned−Observed)/Observed
0.12
0.1
0.08
0.06
0.04
0.02
0
−0.02
Aqua CRS pre−Ed2A (solid)
Rev1 (dashes)
Terra CRS Ed2B (solid)
Rev1 (dashes)
Grant's Jul06 factors (circles)
March 2000 to December 2005



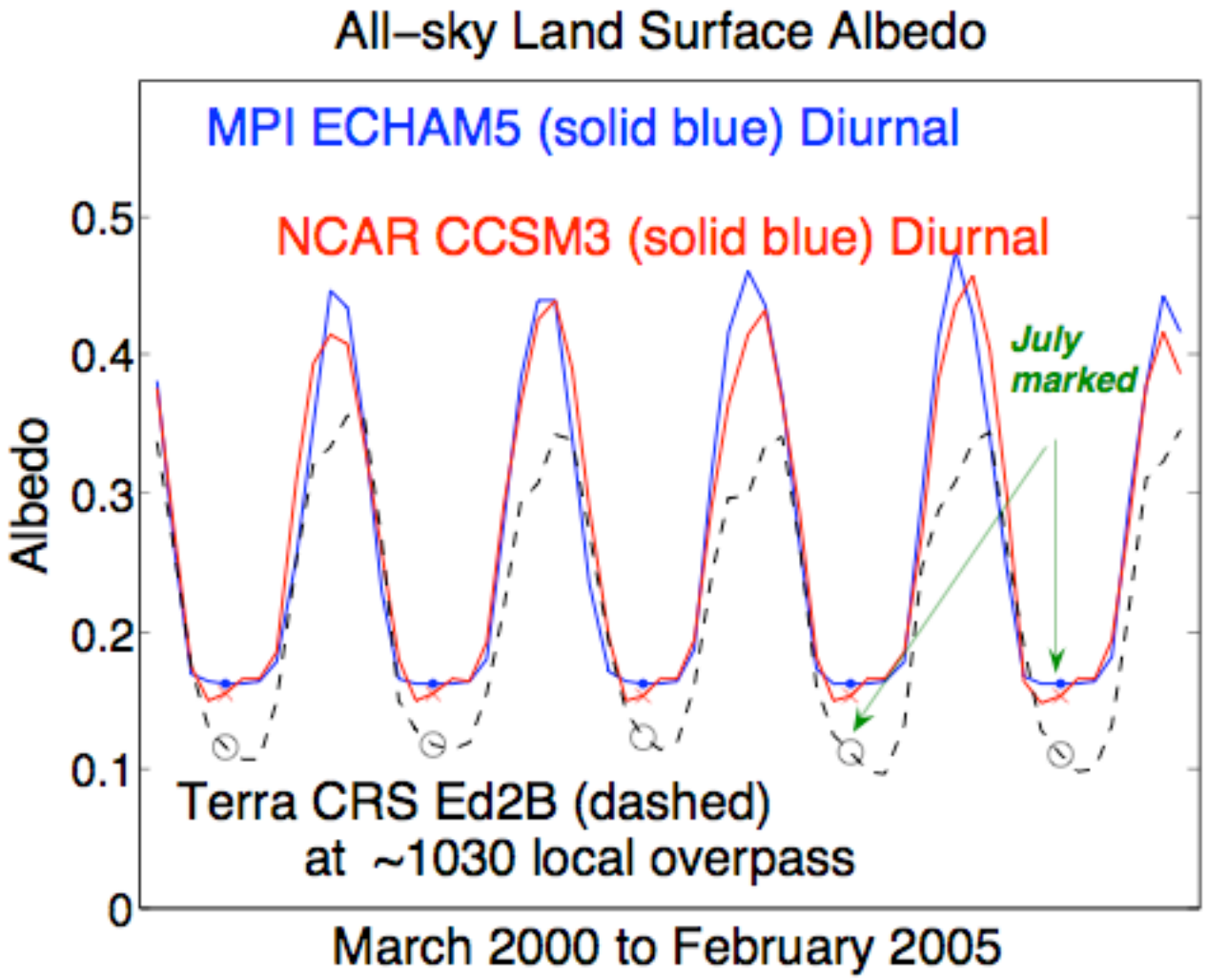
CRS: SARB statistics from the raw field of view (FOV) -- not gridded



Observations by SURFRAD

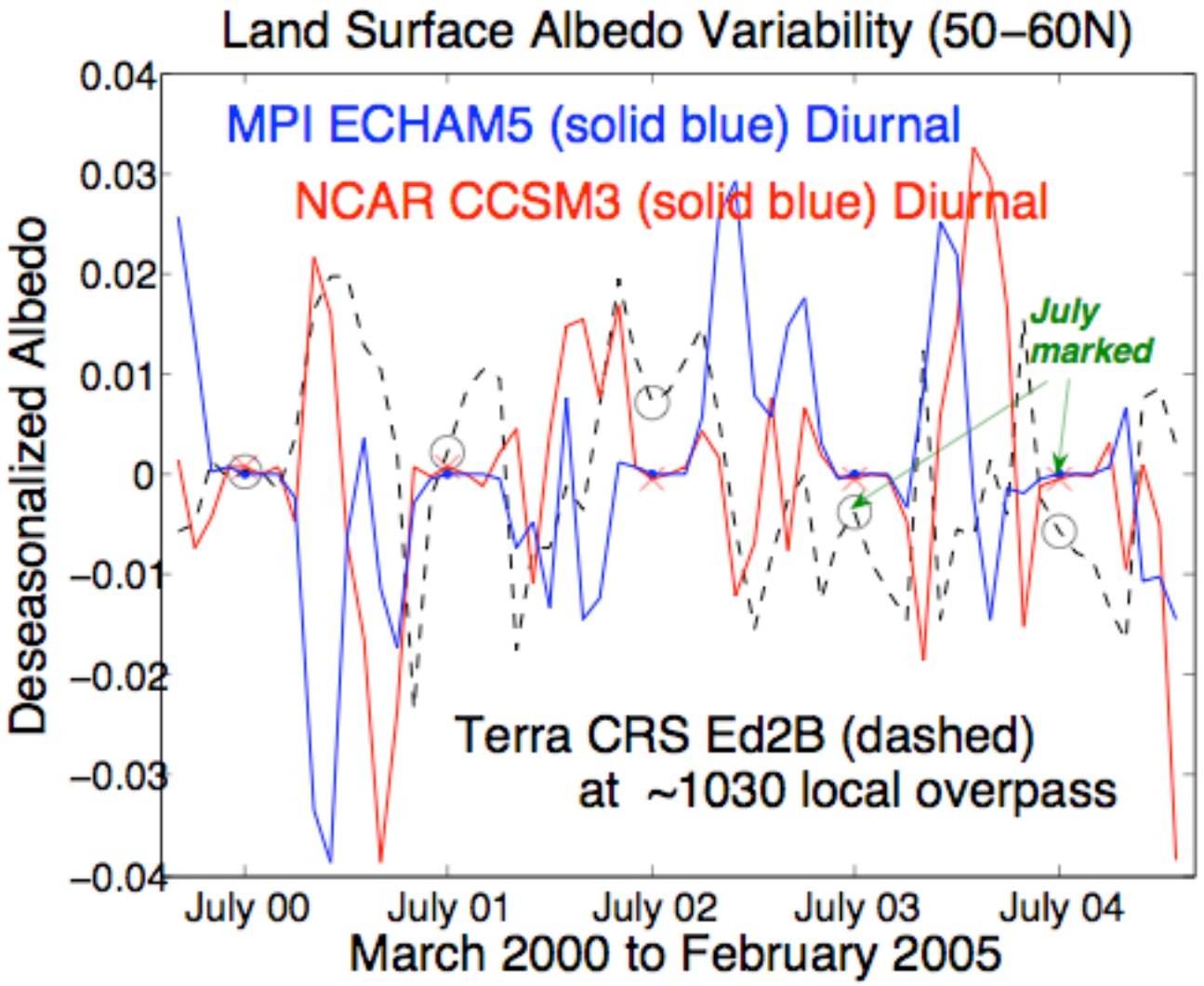

All–sky Surface Albedo at Fort Peck
SURFRAD
slope –0.000775
SARB Ed2B
slope –0.000377
Circles: GTSRTtest Rev1
slope –0.000275
Crosses: GTSRT test No Rev1
slope –0.000338
Deseasonalized Albedo
0.4
0.3
0.2
0.1
0
–0.1
–0.2
–0.3
–0.4
0
10
20
30
40
50
60
70
March 2000 to June 2005

Zonal mean surface albedo 50N-60N

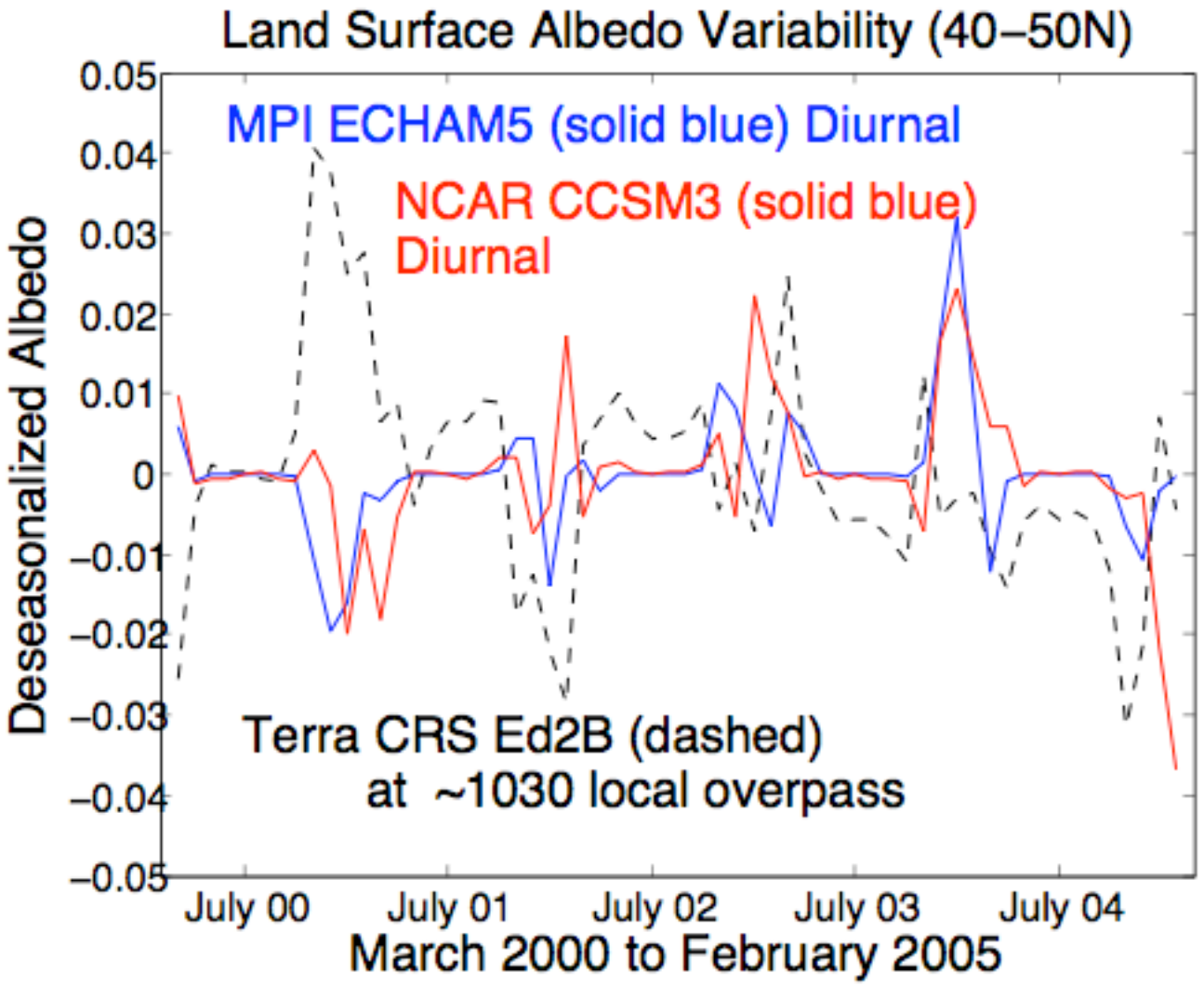


GCM from monthly means with full diurnal cycle.

Retrieved albedos, which are lower, are from high sun Terra overpass.

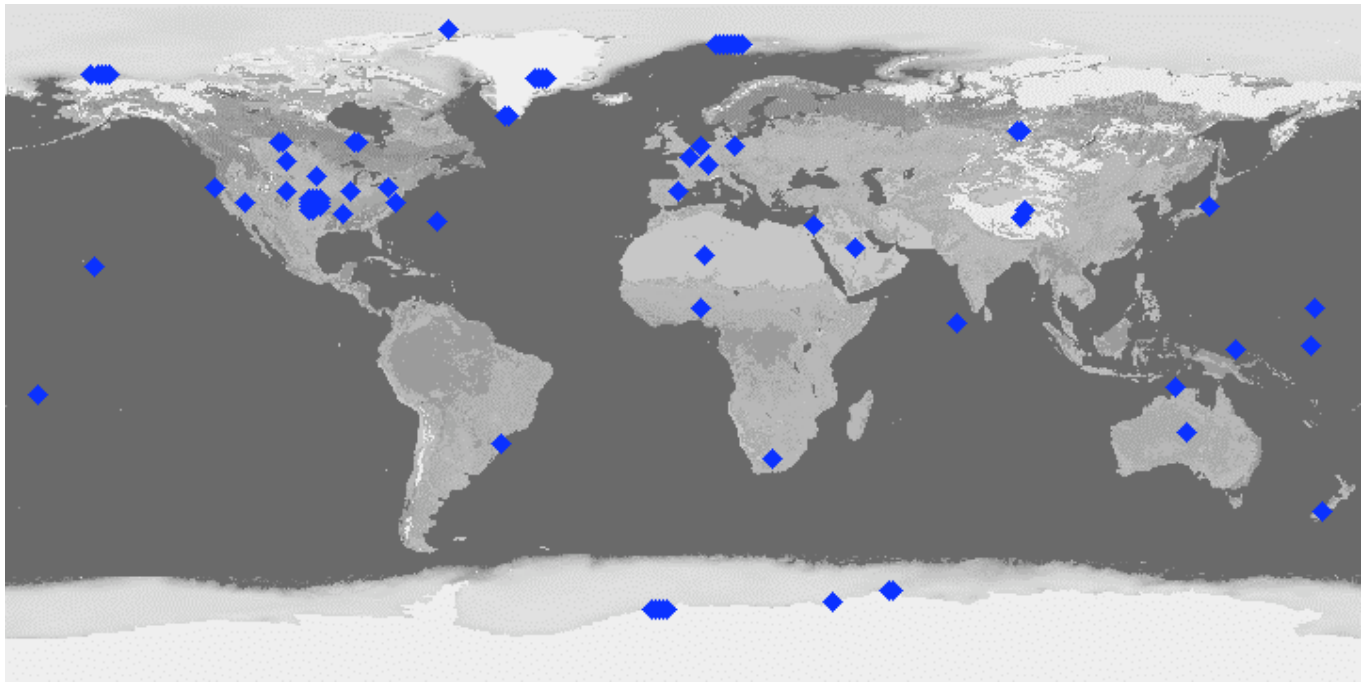


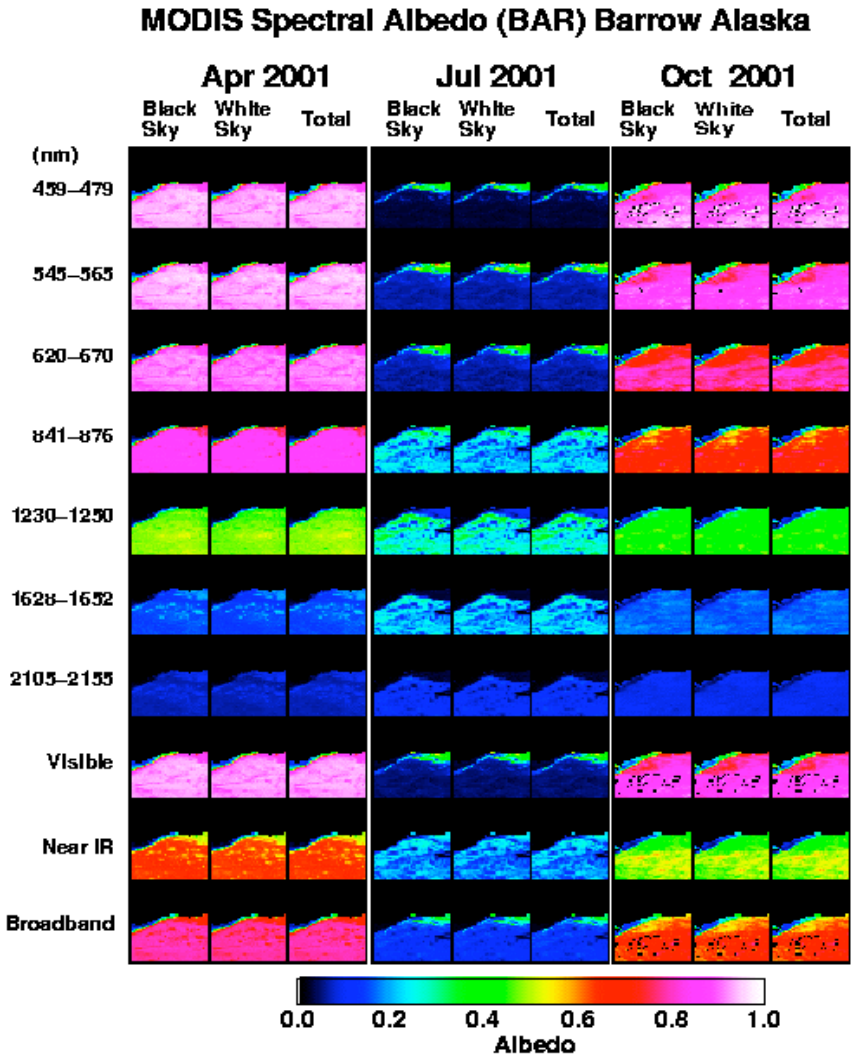
Gridded SARB monthly surface albedos: goggle "CERES CAVE" seek CAVE home page



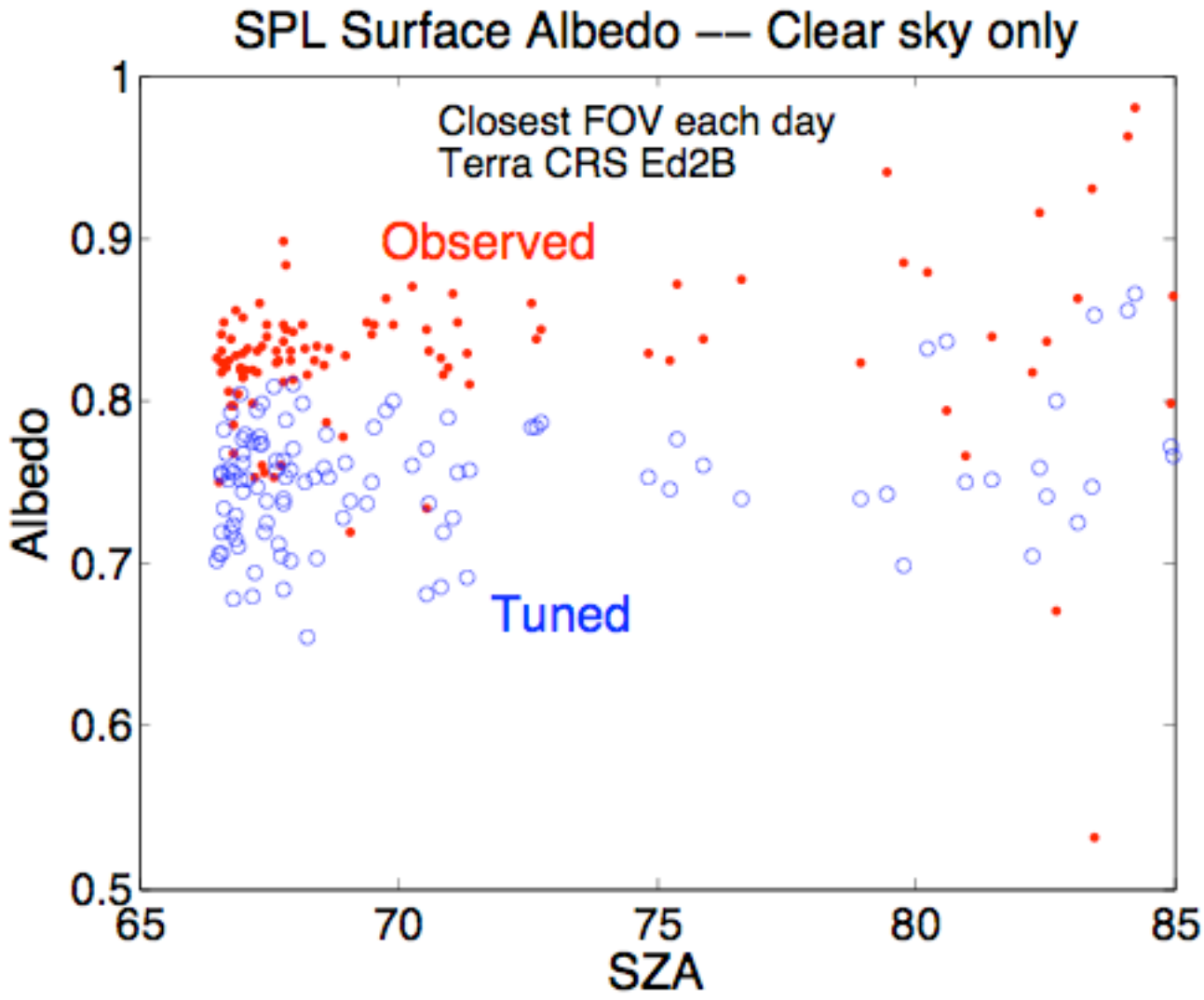
Gridded SARB monthly surface albedos: goggle "CERES CAVE" seek CAVE home page

Sites where we have detailed MODIS surface albedo data

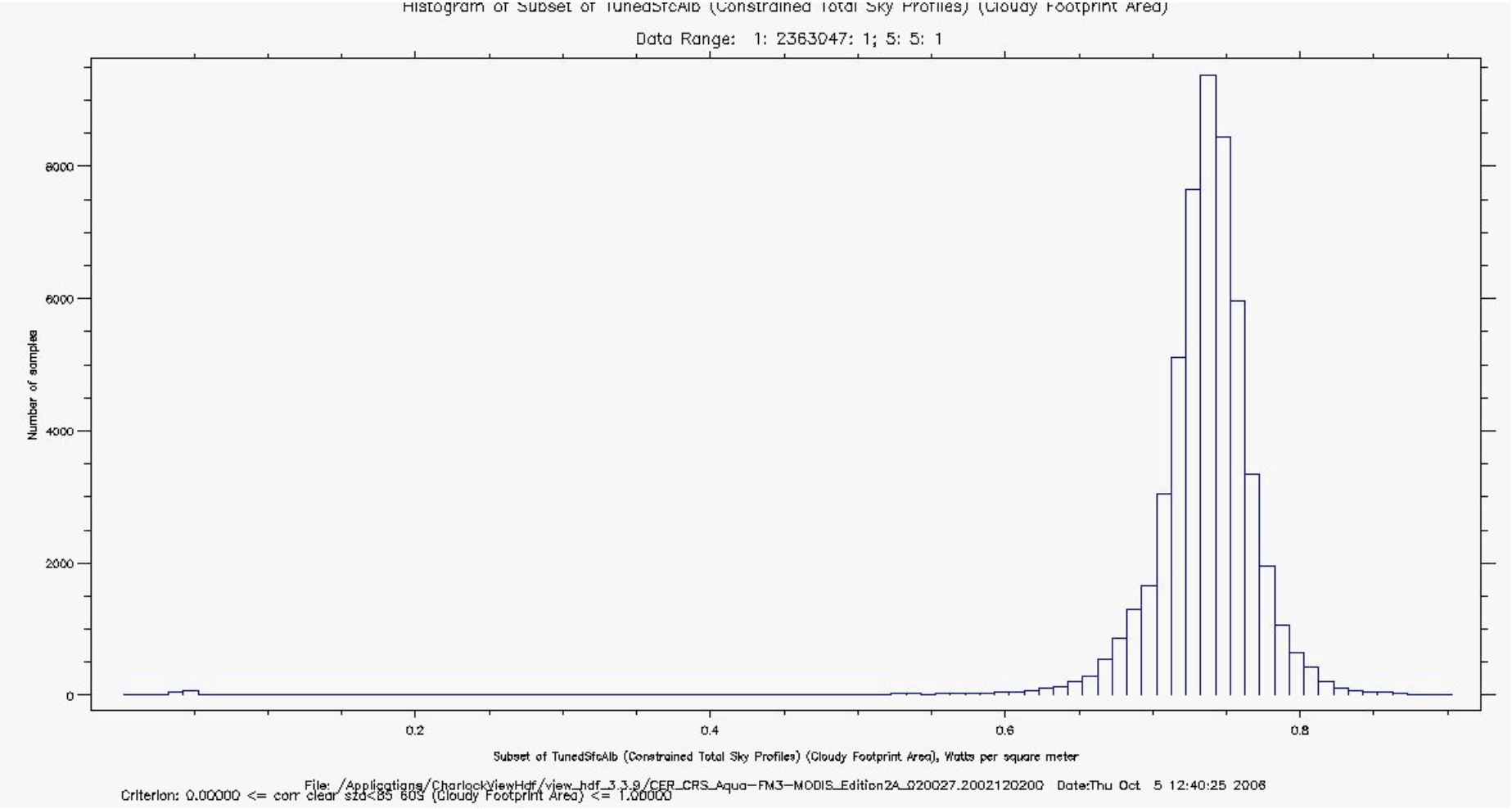



MODIS Spectral Albedo (BAR) Barrow Alaska
Apr 2001
Jul 2001
Oct 2001
Black Sky
White Sky
Total
(nm)
459–479
545–565
620–670
841–876
1230–1250
1628–1652
2105–2155
Visible
Near IR
Broadband
0.0
0.2
0.4
0.6
0.8
1.0
Albedo

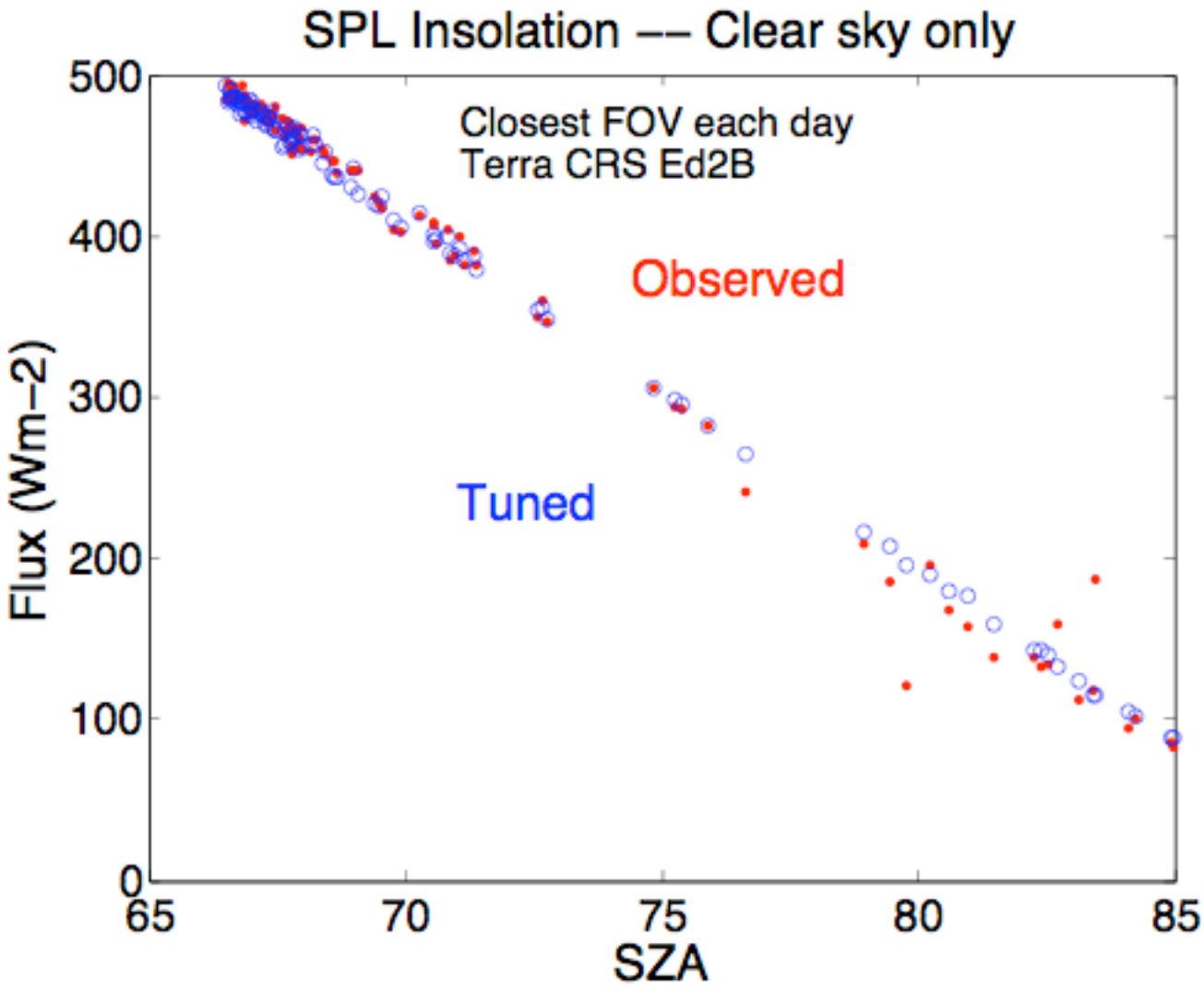
South Pole (Amundsen-Scott)

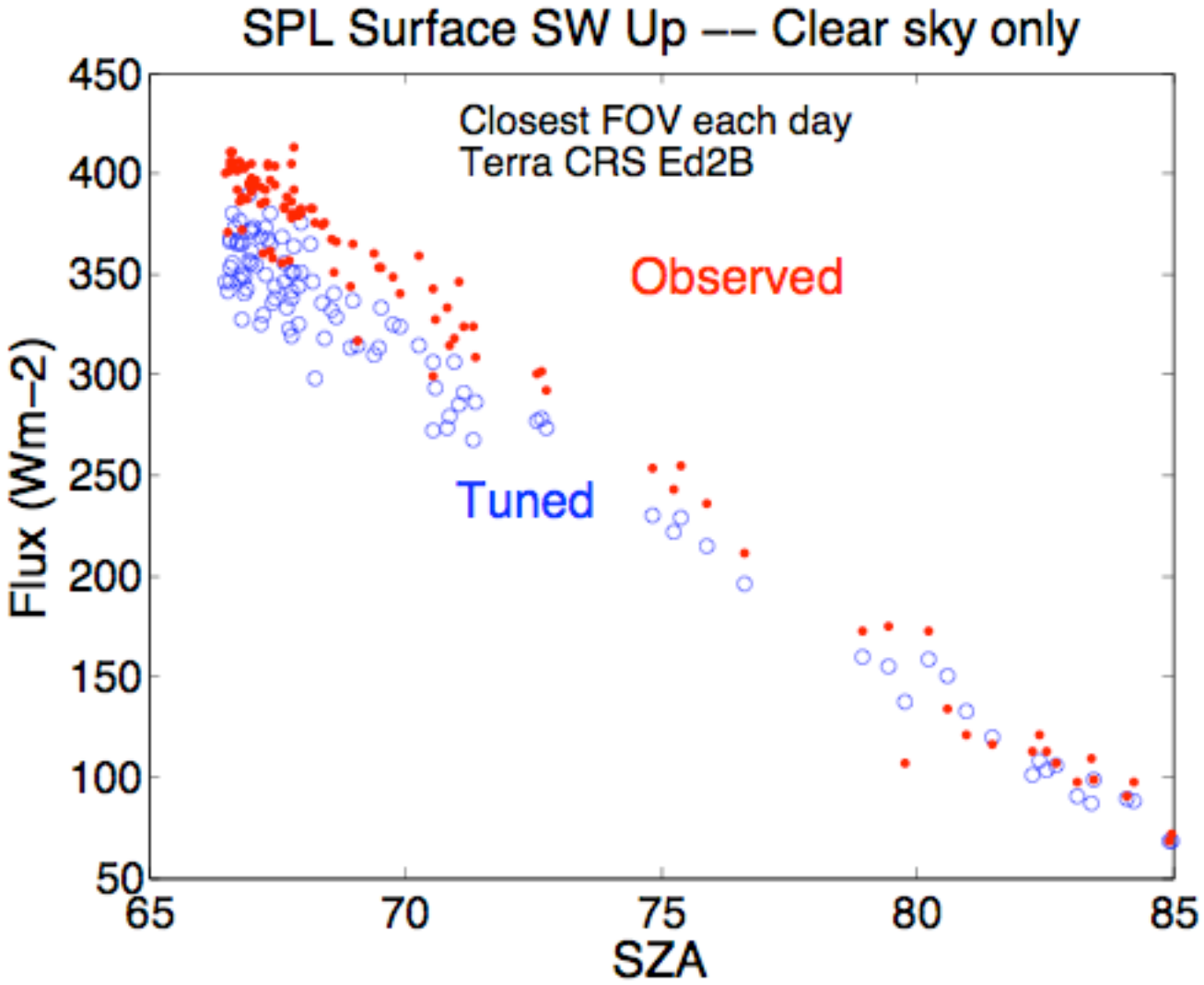


Histogram of tuned clear-sky surface albedo - Antarctic Plateau 2 Dec 02



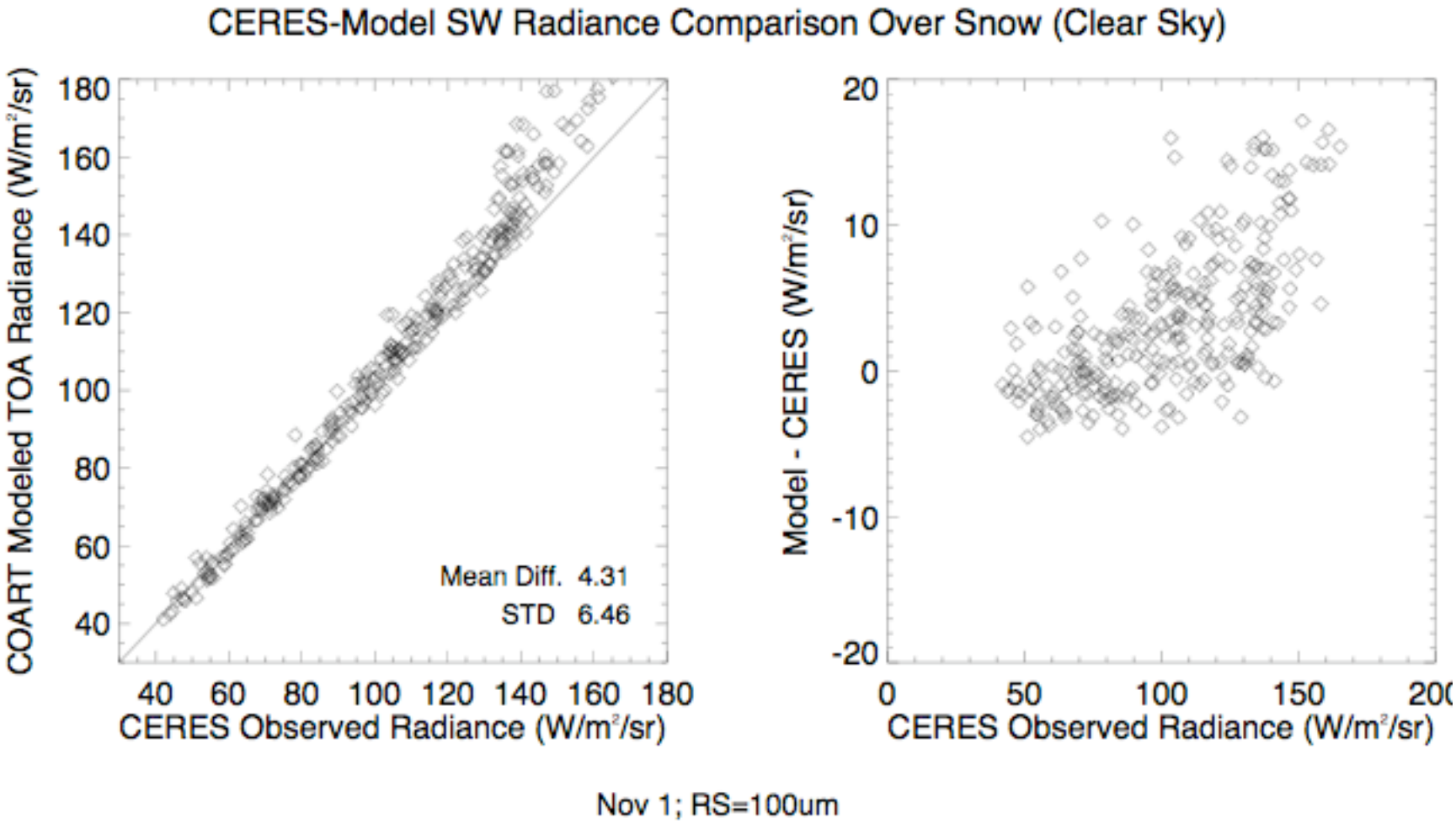
0.0	0.2	0.4	0.6	0.8


SPL Insolation –– Clear sky only
Closest FOV each day
Terra CRS Ed2B
Observed
Tuned
Flux (Wm–2)
SZA
500
400
300
200
100
0
65
70
75
80
85



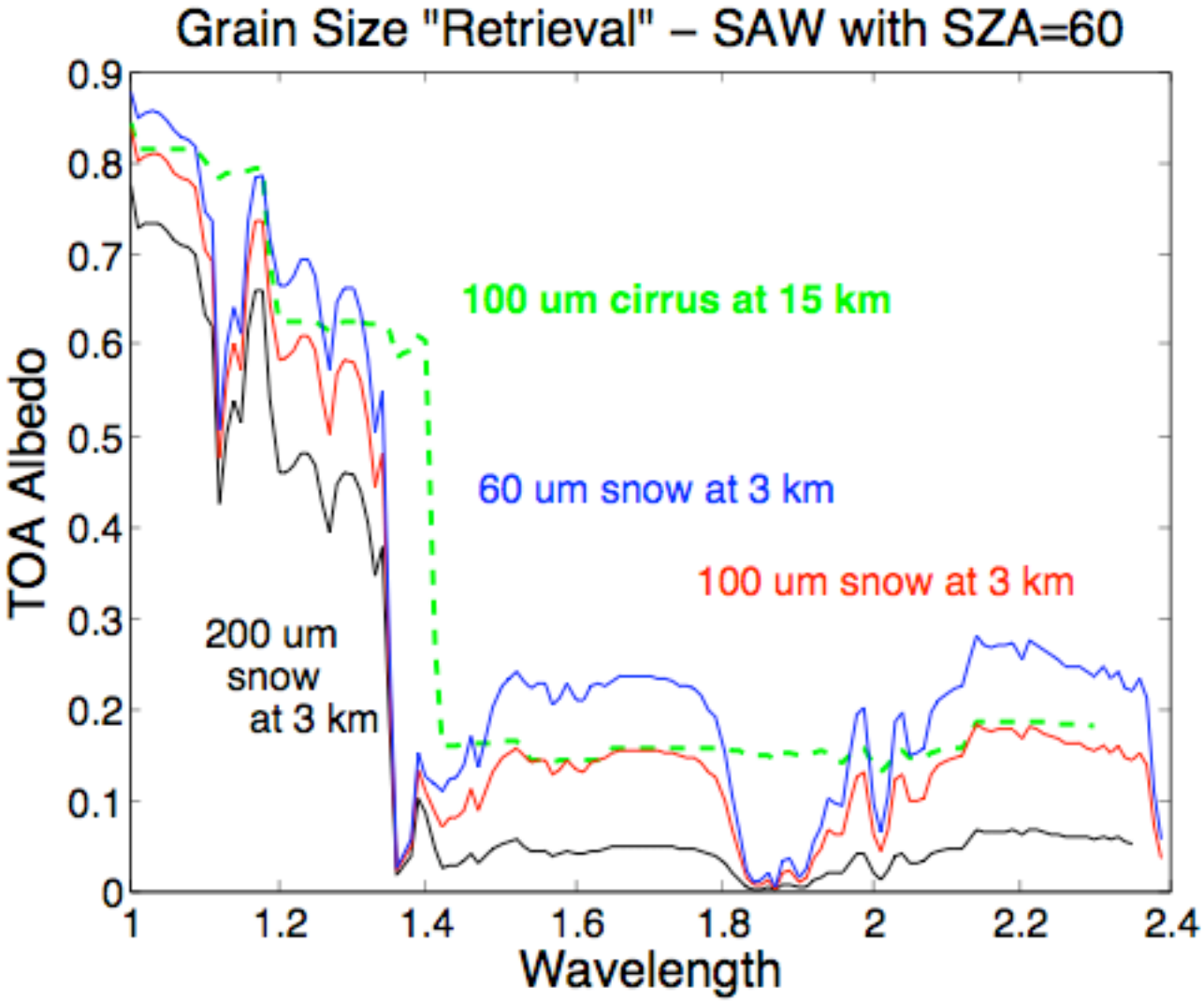
Differences between tuned and observed SW at TOA are here negligible.

If we take a radiative transfer code and input the observed surface albedo at Amundsen-Scott, calculated SW at TOA exceeds CERES… as for clouds over ocean.



Flux:
N=306; Mean_model_flx=363.166 W/m2; Mean_Obs_flx=344.996; STD=12.66; RMS=22.13

Radiance:
N=306; mean_model=107.924w/m2/sr; mean_obs=103.617; STD =5.98567, RMS=7.75301



Calculation done with Jin's COART on line: goggle "CERES CAVE" seek CAVE home page

SARB footprint (FOV) calculations are checked for Terra/Aqua/surface/TOA

- reflect more SW at TOA than observed by CERES (~3-5%) --- ocean

  Evidence for a similar tale over the clear Antarctic Plateau

- transmit more SW to surface for all-sky (~2%) & clear-sky (0-1%) --- land

  Interannual variability for all-sky SW is quite good.

  Interannual variability of snow albedo effect is good.

  Aerosol forcing has some credibility as seasonal mean

  but not for heavy dust sites, where

  aerosols spoil cloudy calculations.

  Schuster will show SARB results for COVE platform

- have less surface LW down than PIR (~10 Wm-2) --- land

- emit more daytime OLR than CERES (0-2 Wm-2)

  And hint at possible drift in observed daytime OLR record

Gridded 24-hour SYNI now under testing; PAR and UV checked independently

www-cave.larc.nasa.gov/cave/ or goggle "CERES CAVE"